IMPROVING PRODUCTIVITY IN U.S. MARINE CONTAINER TERMINALS

Committee on Productivity of Marine Terminals
Marine Board
Commission on Engineering and Technical Systems
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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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Expanding world trade and the consequent fast growth in ocean freight traffic have stimulated the construction of mammoth container ships and larger containers, round-the-world container services, and integrated intermodal ocean and land transportation, with double-stack trains crossing the continent. In the United States this growth has been accompanied by much deregulation of freight transportation. The hub of this rapidly changing international transportation universe is the marine terminal, a complex network of receiving, storing, container stuffing and stripping, and transporting facilities for cargo carried by ships. At marine terminals, cargo is transferred between deep-sea vessels, feeder vessels, and inland transportation modes.

While dramatic change continues to occur in intermodal freight transportation, no such breakthroughs have occurred within the marine terminal since the adoption of containerization in the 1960s. The gantry cranes of today are similar in productivity to those of 20 years ago. Similar methods of materials handling, with similar levels of productivity, also still prevail. The major change has been an immense expansion in size and volume, and hence in the complexity of marine terminal operations. Many in the marine terminal industry, and also many who rely on the efficient handling of cargoes in world trade, have come to feel that the

marine terminal is on the verge of becoming a bottleneck rath than a funnel for world general cargo commerce.

This report appraises issues pertinent to the productivity U.S. marine terminals that handle containerized general carg It was prepared by a committee operating under the auspic of the Marine Board of the National Research Council (NRC The project was requested by the U.S. Maritime Administratio responding to the need expressed by the National Association Stevedores and others in the marine terminals industry.

Members of the committee were selected with regard for t expertise necessary and to achieve a balance of viewpoints. Co mittee members' backgrounds spanned the fields of ocean shippi and transportation logistics, marine terminal design and enginee ing, intermodal terminal operation, port operation, foreign car handling and ship operation, U.S. cargo handling and ship o eration, vessel and terminal integration, transportation syste analysis, and labor. Biographies of the committee members a pear in Appendix A. The principle guiding the constitution of t committee and its work, consistent with the policy of the NR was not to exclude the bias that might accompany expertise vi to the study, but to seek balance and fair treatment.

The committee was charged with investigating issues pertine to the productivity of marine terminals handling general cargo the United States. It was asked to make a preliminary assessme of their relative importance, areas needing further study, a any impediments or barriers to productivity improvement. T committee was instructed to address the following subjects:

- state of the art of technology and engineering design in ge eral cargo terminals, and the state of application and practice the United States;
- comparison with technology and design in other countrie
- interrelations of port and terminal practices, advanced te nology, institutional arrangements, capital investments, ener and other factors, with a view to measurement and improvem of terminal productivity; and
- implications of port and terminal costs, practices, engine ing design, and use of technology for import and export trade the United States and competitiveness of U.S. terminals.

The committee focused its efforts on large, general cargo container terminals because they are the most dynamic sector of the terminals industry and also because containers overwhelmingly dominate U.S. general cargo handling. In spite of this focus, the committee considers much of its assessment of issues, especially its comments on utilization of human resources, to be germane to the entire marine terminals industry in the United States, including other types of general cargo and bulk cargo terminals.

Productive operations imply the most efficient use of capital, labor, and material to obtain optimum throughput of freight. Measuring productivity traditionally involves the ratios of two quantities that generally reflect an input to a process and its output.

The committee was directed to convene a symposium and workshops to investigate these issues and produce a proceedings. Thus, the committee convened the National Meeting on Productivity of U.S. Marine Terminals on January 8-10, 1986, in Long Beach, California. Participants in the meeting included representatives of marine terminals, port and shipping labor and management, as well as technical experts. A list of participants is provided in Appendix B; the agenda of the meeting is presented in Appendix C.

The meeting included a symposium with invited papers and discussion, and workshops to identify and appraise issues. This proceedings contains the invited papers and discussion as well as the reports of the workshops. A summary, with conclusions and recommendations, presents the committee's assessment.

The committee is indebted to all who participated in the national meeting for their willingness to give of their time, for their forthrightness, and for their remarkable professional insight and fair-mindedness. Special thanks are due to Thomas D. Wilcox and Mary Dyess of the National Association of Stevedores and to John Pisani of the Maritime Administration for their sustained encouragement.

CONTENTS

SUMMARY REPORT OF THE COMMITTEE ON PRODUCTIVITY OF MARINE TERMINALS 1
Findings, 1
State of the Art of Marine Container Terminals, 3
Opportunities for Improving Productivity in Marine Terminals, 11

PART 1. WORKSHOP REPORTS

MEASURES OF MARINE CONTAINER TERMINAL PRODUCTIVITY 25
The Elements and Constituencies Involved in Productivity, 27
A Profile of Productivity Measures, 30
Using a Profile to Improve Productivity, 37

ISSUES IN IMPROVING PRODUCTIVITY..................38
New Technologies Requiring Major Capital Investment, 39
Incremental Operational Improvements Not Requiring Capital Investment, 42
Improving Labor and Management Performance and Relations, 44

IMPLICATIONS OF TECHNOLOGICAL AND OPERATIONAL FACTORS FOR COMPETITION AND TRADE ....
Principal Findings, 53

PART 2. SYMPOSIUM PAPERS

INTRODUCTION ....
James H. McJunkin

TRENDS IN WORLD TRADE: IMPLICATIONS FOR U.S. MARINE TERMINALS ....
Richard King
Trends in International Trade, 62
The Role of the U.S. Economy in the World Trading System, 64
International Trade in the Pacific Basin, 65
Government Policy Impact on World Trade, 66
Corporate Strategies, 67

THE MARINE TERMINAL—AN ELEMENT OF TRANSPORTATION SYSTEMS ....

Productivity from a Rail Transportation Perspective ....
David Burns
Improving System Productivity, 70

Marine Terminal Productivity as it Relates to the Trucking Industry ....
Robert A. Curry
Grounded Container Operations, 77
Gate Operations, 78
Available Productive Working Hours at a Marine Terminal, 79

Marine Container Terminal Productivity ....
L. P. Robinson
Who Cares?, 83
How to Improve Stevedoring Productivity, 85
Conclusion, 93

Productivity Concerns in Intermodal Terminal Operations.....94
John Gray

Discussion.....97

U.S. MARINE TERMINAL TECHNOLOGY
AND OPERATION.....104

Technology Development and Application in U.S. Marine Terminals.....104
Frank Nolan, Jr.
The Rail Perspective, 106
Civil Engineering Aspects, 106
Labor Productivity and Manning Levels, 107
Equipment and Facilities, 107
Management Systems, 108
Bulk Cargo Systems, 108
Summary, 108

Marine Terminal Operations in the United States.....109
Dan Rayacich
Container-Handling Systems, 110
Overview of Operating Procedures, 114
Throughput, 117
Container Terminal Cost Breakdown, 118
The Effect of Work Rules on Productivity, 119
Viewpoints Concerning Productivity, 120

Application of Information Systems to Marine Terminal Operations and Productivity.....121
Nancy Friedman
Automatic Equipment Control, 123
Training Technology, 129
Material-Handling Systems, 132
Decision Support Systems, 134
Conclusion, 134

The Human Element in Marine Terminal Productivity.....135
Michael Gaffney and Joel Fadem
Why Change?, 136
Direction of Change, 137
Recommendations, 148

PRODUCTIVITY AT SELECTED FOREIGN MARINE TERMINALS ....

Terminal Productivity at Europe Container Terminus, Rotterdam: A Variety of Factors ....
Joan Rijsenbrij
Productivity: What is the Product?, 149
Productivity Control, 157
Future Trends, 165
Opportunities for Better Productivity and Cost Control, 169

Technology, Operations, and Productivity at Marine Terminals of Scandinavia ....
Calle Westman
Historical Background, 171
Terminal Technology, 172
Terminal Operation, 175

Productivity of Canadian Marine Terminals ....
Richard Kusel
Conclusion, 184

THE IMPORTANCE OF PRODUCTIVE, EFFICIENT INTERMODAL TRANSPORTATION FOR INTERNATIONAL COMPETITIVENESS ....
Robert Kleist

APPENDIXES

A. Biographies of Committee Members ....
B. List of Participants ....
C. Agenda ....
D. Composition of Workshops ....

IMPROVING PRODUCTIVITY IN U.S. MARINE CONTAINER TERMINALS

SUMMARY REPORT OF THE COMMITTEE ON PRODUCTIVITY OF MARINE TERMINALS

In response to a request by the U.S. Maritime Administration, the Committee on Productivity of Marine Terminals was formed to identify and assess issues related to the productivity of U.S. marine terminals handling containerized general cargo. The committee's report is presented in two parts—"Workshop Reports" and "Symposium Papers." This section summarizes the committee's findings and presents its suggestions for productivity improvement in marine container terminal operations.

FINDINGS

The Committee on Productivity of Marine Terminals reached the following conclusions:

1. U.S. marine terminals are generally employing state-of-the-art technology and engineering design. Over the next 5 years, improvements in technology and engineering design will be incremental in nature, building largely upon the existing base.
2. The best U.S. terminals are not as productive as the most productive foreign terminals for many reasons. An important factor influencing productivity is the state of labor-management relations, which runs the gamut in the United States from good to very bad.

3. The most promising area for improving marine te productivity in the United States lies with better employn people. This includes:

- labor-management relations;
- the quality of management and supervision;
- the quality and commitment of longshore workers; ar
- the quality and flexibility of the work environment.

4. Significant potential for productivity gains also res improved information systems to assist in the control of ope and the facilitation of documentation.

5. Improvements in marine terminal productivity are imp to the success of individual U.S. port interests in terms c ability to compete in an economically deregulated, i.e., r driven, environment.

6. The international competitiveness of U.S. manufa competing in the export trade is affected by the quality a ductivity of U.S. marine terminal operations.

7. The committee developed a profile of productivity m to characterize marine terminal performance in a meaning for management purposes, and urges its adoption by tl marine terminal industry (see Table 1, page 14).

8. Substantial improvements in marine terminal prod will come from a process that involves all concerned part continuing dialogue at the national, regional, and local leve process should include:

- joint labor-management cooperation in addressing man resources aspects of improving productivity;
- the establishment of a profile of productivity measu the acquisition, dissemination, and use of productivity described herein;
- the standardization of automated terminal containe fication and management information systems.

The Maritime Administration can facilitate and promote cess by working with industry and labor.

STATE OF THE ART OF MARINE CONTAINER TERMINALS

Container technology was introduced in the 1950s, but it was not until 1966 that the major international trades began to be containerized. Thus, in 1986, there is over 20 years' experience to draw on in assessing the development of the state of the art. This section will summarize the state of the art in the United States, compare it with foreign marine terminals, and provide additional comments on the state of automated information systems in marine terminals, labor-management relations, and other broad issues and concerns.

Marine Container Terminal Systems Engineering and Design

The high fixed costs of marine container terminals impel attention to productivity improvement and most economic utilization. Much has been accomplished to these ends by introducing sophisticated specialized container-handling equipment. To use such equipment optimally, there has been an increased emphasis on systems—in some cases, computer controlled. Other factors that affect terminal use and productivity include layout, ease of traffic flow, engineering, and personnel efficiencies. Ideas currently in various stages of development include high-density multilevel terminals and buffer systems (temporary holding areas) for round-the-clock operations. Among technical improvements sought is equipment that uses less room, is more reliable, and provides greater operator comfort.

Information flow, including freight documentation, is a major area of terminal operations that requires improvement. A consensus approach to standardization and the introduction of automated systems would be beneficial. Another systems engineering area where present methods require improvements is vertical storage of containers and chassis. Methods for stuffing and stripping freight also are ripe for improvement.

No doubt there are barriers to innovation. Development of ideas, systems, and methods require both human and financial resources, frequently not forthcoming in an economically lean climate.

By and large the marine terminal industry in the United St does not engage in ongoing systematic research into its ec ment and systems requirements, but usually leaves this func to outside consultants that are brought in for specific proj A limited amount of development and testing is done under Cargo Handling Cooperative Program (CHCP), establishe the U.S. Maritime Administration in partnership with U.S. carriers.

Operating Systems

Marine Container Terminal Operations

U.S. container terminal operating systems are almost ev divided between chassis systems (46 percent) and stacking grounded, systems (54 percent). There appears to be no indication as to which of these systems is superior in term productivity. The users of either system understandably c that their system is more productive and cost-effective. The ch of systems may be influenced by the availability of laydown a (space to set containers as they await transshipment) within distance of the ships' berths. An important intangible factor in comparison is customer satisfaction—particularly in connec with pick-up of import containers. In this area the chassis sy is clearly superior, as it minimizes waiting time. However, du the high capital cost involved, it is rare for a carrier or term to switch from one system to the other once the initial choice been made.

Throughput at U.S. container terminals is low (as a percen of capacity) in comparison to many terminals in other coun There is a consensus that this is due in part to terminal overca ity, caused by intense competition among ports. Carrier prefer for private terminals has contributed to American ports havi reserve capability which indicates that, by and large, there is little need if any for further expansion during the next se years, except for those ports that have attracted considerabl ditional traffic.

Overall cost of terminal operations is generally broken down labor, terminal lease costs, capital cost (including maintena and overhead. In the United States, labor is the major compo in all situations. Because labor costs are sensitive to the effic

of terminal use, labor costs have the widest variation from one terminal to another. Many other factors also bear on the final figure, particularly work rules which vary from region to region.

Rail Operations

With few exceptions, the interface between marine terminals and railroads involves some drayage (movement by truck). As a result, the basic relationship between marine terminals and railroads is similar to that between marine terminals and truck operators.

Some potential improvements are suggested by a railroad request that special lanes be set aside for volume movements between marine terminals and rail yards and also that marine terminals adopt more flexible working hours in response to user needs. Another suggested area for attention is the creation of neutral chassis pools to minimize fluctuations in chassis requirements. Also, railroads recommend the creation of surge facilities to deal with peak situations, which would otherwise clog either the marine terminal or the rail facility.

Finally, there is the ultimate question of how to eliminate drayage between marine and rail facilities. This has been resolved in many foreign terminals by constructing pier-side rail facilities (see following discussion on intermodal operations), which has certain attractions. However, in terms of state of the art, the concept is largely untested in the United States.

Intermodal Operations

The most significant development in connection with the intermodal aspect of containerization has been the double-stack train concept. This has led to volume movement of a previously unheard-of quantity and a corresponding reduction of line haul cost. It has also brought in new technology and systems, particularly in connection with rail operations. However, few U.S. container terminals provide on-terminal transfer facilities. Drayage is necessary in all instances. Any attempt to establish on-terminal transfer facilities will confront complex trade-offs.

Container yard space represents a serious impediment. A double-stack container train is typically a mile long; few existing terminals can accommodate such a train. The presence of entire

handling facilities will be reluctant to adopt major changes in the current operational pattern.

Solutions to improved on-dock transfer systems will depend on the incentives offered to the parties affected—ocean carriers, port authorities, terminal operators, stevedores, longshore labor, truckers, and railroads. Any breakthrough to a new system is likely to become an innovator/follower situation. Once there has been a breakthrough, competitive pressures on others will follow.

Truck Operations

The problems experienced by truck operations in their interface with marine terminals are very similar to those of railroads and are amenable to similar solutions, i.e., special lane requirements or flexible working hours to minimize peaks. In addition, truck operators put particular emphasis on the need for smooth documentation procedures to minimize turnaround time. Prechecking procedures have helped to reduce delays caused by documentation snags.

An unrelated but important aspect of the quality of truck operations comes from the impact of trucking industry deregulation. This has caused a large share of the work to be taken over by owner-operated trucks which, in some cases, operate without proper authority or insurance and without observing required maintenance and safety standards.

Terminal Management

While optimum design capacity of the average container crane is in the 40-45 lifts per hour range, the U.S. average performance is only slightly above 20 lifts per hour or less than 50 percent of design capacity. This contrasts with an average performance of 30-35 lifts per hour in European and Asian terminals.

In improving productivity, terminal management must take account of the technical features and requirements of the vessel, the

terminal cranes, and the terminal operating systems as well as labor-management relations. By and large, new technology for vessels, cranes, and operating systems is incorporated into terminals when it is cost-effective. However, there is real need for improvement in management and labor relations. Shortcomings in this vital area are the result of the combined impact of poor planning, poor management, and poor labor. Frequently, management has abdicated its planning responsibility to labor. Labor, in turn, is neither adequately trained nor motivated to perform this function efficiently. There appears to be very little rapport with the labor force under present practices. An in-depth analysis of these issues is needed to bring about better management, better labor, and better management and labor relations.

Information Systems in Marine Terminals

As in many other industries, operational managers are becoming knowledgeable in modern computer systems. New systems typically are introduced into operations by means of a series of test programs and subsequent reviews. The new climate has encouraged the marine technical industry to evaluate and apply emerging information technologies.

Automated container-identification procedures are in various stages of research and development with significant development and testing being conducted collaboratively by the shipping companies, which also operate terminals.

At present, material-handling systems are generally manually operated. One of the few U.S. terminals to have gone beyond the experimental stage in advancing the state of practice of materials handling is Matson Terminals, Los Angeles, California. Matson employs computer process control to minimize crane travel time. Microwave technology is employed to track the placing and picking up of containers. Among foreign terminals, the Europe Container Terminus (ECT) in Rotterdam, The Netherlands, employs laser technology to monitor the location of container-handling equipment.

In the past, the container terminal industry sometimes created "islands of automation." Where this situation existed, the benefits of improvements in the automated area of the overall operation could not be fully realized due to barriers in other areas of the

terminal system. In order to achieve maximum benefit from
vanced and expensive information technology, it will be necess
to identify such bottlenecks and then to correct their impact
the overall productivity of the terminal.

Labor-Management Relationships

The introduction of containers and container systems le
serious labor disputes. Initially, the issues focused on the siz
the labor force and the problems of redundancy created by
higher levels of productivity made possible under the new sys
Over the years the issues have remained complex.

Escalating competition has brought on a need for reduced c
In several areas, ports and employers have even looked to alte
tive labor unions or, in some cases, nonunion labor. The prin
underlying economic force has been the need for a reductio
gang sizes to bring down the total cost to an acceptable com
tive level. Such pressures have been particularly prevalent o
East Coast and Gulf Coast, where the existing labor cont
are tied to large gang sizes. Reductions in the work force
raise social issues and present new issues on how to maximiz
effectiveness and safety of the reduced force.

Stability of employment is an aspect of labor and manage
issues that has defied an efficient solution. Modern manage
techniques point in the direction of core labor groups that
be employed on a steady basis, supplemented by casual l
This system, patterned on Japanese practices, is gaining
application. At the same time, the technique favored by orga
labor pulls in the opposite direction through the mechanism
hiring hall, which serves as a means of distributing work a
union members.

Impact of Government Policies on Container Terminal

Government trade, political, and military policies all inf
the maritime industries. Governments sometimes support or
dize unproductive practices in foreign trade as matters of st
concern. While measuring the impact of such practices is di
the reality of their existence cannot be ignored.

Particular mention should be made of the clear U.S. government policy of deregulation. The impact of this policy on marine terminals has been indirect, primarily in the form of changing patterns of inland intermodal transport. A case in point is the accelerated development of landbridge and minilandbridge rail services. In a relatively short time, these new concepts have captured a large share of U.S. foreign trade with Asia. Likewise, deregulation has lowered the cost of terminal trucking operations, with the overwhelming volume of container transfers to rail being handled by owner-operators.

Comparison of U.S. and Foreign Marine Container Terminals

As observed previously, container cranes in European and Asian terminals today generally operate at a rate of 30-35 lifts per hour, which represents a productivity of about 30 percent over U.S. operations.*As impressive as the present overseas productivity is, it pales in comparison to the target set by the more progressive terminals; for example, the ECT in Rotterdam has the goal of 40 lifts per hour by the year 2000. It is clear that much of the expected productivity improvement must come in the area of stacking systems (stacking operations being the prevalent system in use in most European and Asian terminals). Other key areas receiving attention are information and gate control procedures. Some of these terminals put particular emphasis on modern computer systems featuring exhaustive data communication capabilities to

* While there is clear indication that many foreign terminals have better productivity than some U.S. terminals, this distinction often depends on the method used to measure productivity. The difference is most significant when compared on a per-man-hour basis, particularly when comparing U.S. East Coast and Gulf Coast terminals with foreign ports. This is most obvious when a comparison is made with Canadian ports, where relatively high productivity has been achieved with considerably smaller gang sizes compared to the U.S. East Coast and Gulf ports. The existence of this difference in productivity has been a major factor in generating cargo diversion to Canadian ports. In the direct trade with U.S. trading partners, the differences in productivity have no measurable impact (import and export movements in either direction will be faced with practically identical costs, granted in the reverse order). However, the lower U.S. productivity has an adverse effect when U.S. export trade is competing with other trading nations to serve third-country markets.

There is clear recognition among the efficient foreign te operators that much future growth in productivity will ha come from advances in the employment of human resources. ing and motivating the labor force is viewed as essential. T particularly the case in Western Europe and in Japan whe cost of labor represents a major portion of the overall co some cases as high as 60 percent. Taking all technological opment into consideration, the key factor to a successful ope is still considered to be the quality and motivation of manag and labor. The most successful foreign terminal operation ploy participatory management systems that encourage lal contribute to improvement in methods, equipment, and wo conditions. They keep employees informed about the qua their performance, and they reward them when they achie nificant improvements. They stress employees' identificatio their work, whether individually or as a group.

In practical terms, the foregoing is being achieved by o ing with a proportionally higher share of regular employee perform their tasks in decentralized units. This leads to motivated teamwork. The management function is well del to middle management. For the increased share of the wor under regular employment, the proper mix of individual r sibility, job satisfaction, information availability, clearly d employment conditions, proper training, and safety proc leads to proper motivation and increased productivity.

The nature of the European traffic system is such that are important considerations to be taken into account befo comparisons are made between their terminal handling sy and their U.S. counterparts. One key difference is the fact t the European feeder systems there are a far larger number on/roll-off (Ro/Ro) vessels. Likewise, in European deep services the Ro/Ro vessel is also employed on a more fr basis. Another difference should be noted in connectio stack/rail/stack transfer operations, which frequently take directly at the marine terminal. Both differences create di

(and more complex) terminal traffic problems. Nevertheless, the overall foreign terminal productivity is superior to that of U.S. terminals.

Canada presents an interesting contrast to the United States. While Canadian trains are comparable to those operated in the United States (both in terms of the train's composition and the distances involved in overland operations), the intermodal transfer usually takes place at the marine container terminal (without drayage). The similarity in rail operations and the contrast in terminal operations between the United States and Canada would appear to point toward a further detailed study of the potential for applying Canadian intermodal practices and systems to U.S. terminals.

Another area that a comparison between U.S. and foreign terminals must take account of is government rules and regulations. For example, safety rules have a measurable impact on terminal productivity. In those unfortunate instances where there has been an accident involving death at a terminal, a substantial drop in the rate of productivity occurred at the terminal after the accident. In the long run productivity has reverted to its earlier, higher level. No doubt these situations have helped improve safety standards for marine terminals.

OPPORTUNITIES FOR IMPROVING PRODUCTIVITY IN MARINE TERMINALS

Efforts to improve productivity in marine container terminals must balance the needs of the many constituencies that affect the terminal. Improvements within the terminal should be accomplished without adding to the total cost of transportation. The question of improving terminal productivity, therefore, must be viewed within the broader perspective of the customer of transportation service and the total cost of service.

Improving productivity is accomplished by change—for example, by replacing one element of cost with a lesser element, perhaps capital for labor, by eliminating unnecessary work and delays, or by providing required communication in its broadest sense.

The options of the terminal operator are often limited by his surroundings. Generally, the port authority provides him with a pier and land, thereby fixing the upper level of volume. The size

of chassis and the requirement that all containers be moved o
wheels.

The constituencies who affect the terminal have different goal from those of the terminal operator. The trucking communit wants to turn their equipment rapidly through the terminal. Th ocean carrier wants a rapid turnaround at berth requiring tha as many cranes as possible work the ship. As a consequence th terminal must gear up to provide that service and incur more idl time for a possibly greater set of equipment and its underlyin capital. Members of the collective bargaining units want job se curity and high pay, which may be at variance with the termina operator's needs to improve productivity and to hire the numbe of workers that is economically justified.

Measuring Productivity— A Precondition to Improvement

In order to manage a process, it is necessary to measure it. Th management of a marine terminal is no exception. The measure ment of marine terminal productivity is quite unlike the measure ment of the productivity of, say, an assembly line. First, no tw terminals are alike. Second, in any given terminal, no two shi worked are exactly alike in configuration or loading. The result that the work performed in a terminal is repetitive only in a gro sense.

A marine terminal is complex in that it involves a variety of m jor components (such as the berth, the cranes, the container yar the gate, and, of course, labor) and various constituencies th play a role in the operations of combinations of these componen (the port, the shipping line, the terminal operator, the stevedori company if different from the terminal operator, the truckers, a the longshoremen). This complexity excludes the possibility th one single measure of productivity can encapsulate the essence all of the interactions between components and constituencies a still reflect the efficiency of the operation in a meaningful way.

alternative approach to the measurement of marine terminal productivity was developed during the course of this study (see Table 1). (The proposed profile of productivity measures is described in detail subsequently in the workshop report "Measures of Marine Container Terminal Productivity" [in this volume].)

Productivity is commonly measured in monetary terms, since management often views increases in productivity as a means to increase profits. Within a given terminal such measures do have considerable relevance. However, different terminals may well be in different labor markets, use different currencies, and be subject to different physical and environmental constraints. Thus, it is not clear that such monetary measures of productivity are either meaningful or useful when comparing different marine terminals. As a result, the profile of productivity measures developed by the committee involves physical quantities such as man-hours and crane moves. In this way it is hoped that meaningful comparisons can be made among terminals both here in the United States and abroad.

The concept of a profile of productivity measures was the result of an attempt to characterize all the principal areas of operations of a marine terminal with the smallest number of measures. Many of the measures in the profile are not now in common use. Those involved in marine terminal operations have their own in-house productivity measures used on a day-to-day basis. It is not the intent of this section to suggest that these measures be abandoned. Rather, the purpose of a profile of productivity measures is to develop a common language to communicate the performance of one terminal in a context that can be understood by others. The proposed measures, because they involve careful definitions of terms, are also the beginning of a standard dictionary of terms. This standardization will further promote communication on marine terminal productivity and show how to improve it. As a result of variations in labor conditions, terminal operations, geography, and other variables, the profile of one terminal should have some measures of productivity inferior to, and others superior to, those in the profile of another terminal. Understanding these differences should lead to an understanding of the relative operations of each terminal and its strengths and deficiencies.

TABLE 1 Profile of Productivity Measures

Element of Terminal	Measure of Productivity	
Crane	Net crane productivity:	$\frac{\text{moves}}{(\text{gross gang hours} - \text{downtime})}$
	Gross crane productivity:	$\frac{\text{moves}}{\text{gross gang hours}}$
Berth	Net berth utilization:	$\frac{\text{container vessel shifts worked per year}}{\text{container berths}}$
Yard	Yard throughput:	$\frac{\text{TEUs/year}}{\text{gross acre}}$
	Yard storage productivity:	$\frac{\text{TEUs capacity}}{\text{net storage acre}}$
Gate	Net gate throughput:	$\frac{\text{containers/hour}}{\text{lane}}$
	Gross gate throughput:	$\frac{\text{equipment move/hour}}{\text{lane}}$
	Truck turnaround time:	$\frac{\text{total truck time in terminal}}{\text{number of trucks}}$
Gang	Gross labor productivity:	$\frac{\text{number of moves}}{\text{man-hours}}$

he measures of productivity proposed are interdependent. ; is, an increase in yard productivity (by storing more contain- n the yard) can easily lead to a decrease in crane productivity gate productivity, since the efficiency of storage and retrieval tions in the container yard may suffer. Improving the oper- ı of a given terminal inevitably involves trade-offs between)perating elements in order to optimize profitability and per- ance. The manager's task is to perform these trade-offs and ıtegrate the whole system. This optimization process must with local costs in explicit terms. The proposed profile of uctivity measures will illuminate the nature of the trade-offs ted, but will not expose the actual costs.

l to Gather Data

order to profile productivity measures for comparative pur- s, it is necessary to have profiles from several different ports. ecting these data poses significant problems. As previously tioned, these productivity measures are not now being col- :d, and many of the proposed measures are different from e in current use. It is easy to understand the reluctance of the viduals involved in terminal operations to identify and collect t of new data. However, the data base provided by the col- on of these profiles will be valuable for comparison with other ıinals and make up for the cost of the data collection.

ollection of productivity data is a sensitive issue, particularly ıuse of the extreme competition that exists in the industry and overcapacity of the ports. Careful consideration needs to be n to ways in which the data can be presented anonymously, ıat the competitive stances of individual shipping or terminal :ators are not compromised.

n opportunity exists for the ports to take the lead in data ection at the local level. Many ports already require regular nission of some productivity data from their client terminals. ıdardization of this process would lead to development of the ıired data at each of the major ports. A need would still exist ollect these data from the individual ports, to assemble and ate them, and to disseminate the data back to the interested ;ies.

ample, many ports use similar types of container cranes, althou
much of the other parts of the operation can be quite differe
One would anticipate that two ports with similar cranes shou
have similar crane productivities. The extent that they differ in
cates some inhibiting factor in the port having lesser productivi
The complete profile of productivity measures provides a pictu
of the other parts of the operation so that these influences can
assessed. The detail included in a complete profile of productivi
permits the assessment of productivity deficiencies to be made
all levels of management, particularly at the lower levels whe
direct contact between labor and management occurs.

The data base of terminal productivities will indicate the resu
of the different trade-offs made at individual ports, and shou
therefore reveal the sensitivity of any one productivity measu
to another. To optimize the profitability of a given terminal o
eration, each individual measure must be converted to local co
This provides a common base to combine the effects of all of t
measures. The sensitivities indicated by the data base togeth
with the local costs can predict the financial impact of change
any of the primary aspects of terminal operations. Because lo
costs vary from terminal to terminal, the resulting optimal bala
at one terminal is likely to be different from another terminal.

It should be noted that the profile of terminal productiv
does not address the cost of management of the terminal. Th
overhead costs must be added to the direct operations cost
the total cost of the operation (or equivalently, the total cost
container handled) is to be determined.

The profile could be used to set productivity and incentive go
The profitability of a marine terminal can be particularly sensit
to productivity. As a result, it seems reasonable to tie producti
performance together with labor contracts, so that labor can sh
in both the benefits of good productivity and the costs of poor p
ductivity. With unambiguous and easy-to-calculate producti

measures and, most importantly, with evidence of attainable levels of productivity in other ports, the use of these measures as incentive goals seems valid. As an alternative, historical records of productivity covering many ports may also be used as part of the collective bargaining process.

Ship scheduling is sensitive to the productivity of marine terminals. High berth utilization (because the terminal is productive) can lead to delays in obtaining a berth. Low crane productivity and low yard productivity can lead to delays in ship turnaround times. Knowledge of these factors should influence the shipping line to develop sophisticated scheduling strategies to account for these possibilities and to minimize their influence on its operations.

Improving Productivity Through Capital Investment

The preceding section on the state of the art of marine container terminals explained that the marine terminal industry generally is using the latest available technology shown to be cost-effective. Some of the technologies being developed abroad, although they could improve productivity, are not cost-effective in the United States at the present time (except in a few instances). These include:

- dual trolley cranes (capable of handling several containers at once)
- automated cranes
- automated container storage and retrieval systems
- automated guided vehicles
- buffer systems
- multitrailer systems
- cell guides for deck storage
- automated trim and list control systems

This situation exists because a considerable portion of U.S. terminal resources are underutilized. Therefore, a primary objective for the industry must be to increase productivity and the use of the current plant through operational and management-level improvements. As a general rule, capital improvements should be

to improve flow of information in the terminal. Information is the glue that holds the operation together, linking the customer, management, and the work force. Better information provides all levels of the terminal with the vital information needed to improve the rate and the doing of work and may provide the basis for better integration between management and terminal workers.

For each operation in the terminal a specific container must be moved from a known location to a required destination. Any improvement in this process of identifying locations and containers will not only help the planning of yard and vessel moves, but will also provide feedback to assess the quality of the operation for future improvements.

In addition to the means for improved planning, the equipment operators must have exactly the same information. With information flow improved in this manner much of the delay currently endemic in today's terminals will largely disappear.

Some aspects of this specific area of opportunity for improving productivity are now starting to be addressed by the CHCP, which addresses the problem of automatically identifying container equipment and location with a high degree of accuracy and wireless transmission of digital information. Current work involves testing the durability of this equipment in the marine terminal environment and on the high seas. This effort on the part of the industry already is beginning to show that standardization of the electronic hardware and software is mandatory if terminal operators are to uniformly reap the potential benefits of this work.

Improving Productivity Through Operations Research

Since many marine container terminals tend to be underutilized, improvements in operating the existing plant must be the first order of business in the marine terminal industry. This involves searching for areas that have less productivity than could logically be expected. The profile of productivity measures that has been

B4

suggested can help in this regard. Making incremental improvements will require additional analytical work, however. This work needs to stress the analysis of the interaction of one segment of the terminal operation with prior and succeeding operations and with events outside the terminal. These analyses should look at the functional aspects of operation such as:

- the layout and planned flow of equipment in the terminal;
- the effect of outside forces that impinge on productivity in the terminal, such as vessel arrivals, interchange to trains and barges or feeder vessels, and gate arrivals;
- the organization and assignment of the terminal work force;
- the planning operation for working the vessel and yard;
- the manner in which normal flow of containers is handled versus the movement of containers that demand service outside of the normal handling routines (the latter could be containers with late arrivals at the terminal or containers whose clearance for export is changed at the last minute);
- the operation of the gate, which can present waiting-line problems that could be ameliorated by standard techniques of specialized handling of equipment with short service time requirements; and
- the operation of gantries and other yard-handling equipment. Gantry delays can be due to an inadequate support operation from the yard. Delays can also be due to impaired vision available to the crane operator. Some of these could be corrected with improved markings of locations, others with improved guidance systems, the use of contrasting colors, appropriate aids for stopping under handling equipment, and improved gathering devices on lifting beams and for chassis.

Improving Productivity by Improving Working Relationships

Different marine terminals that use comparable equipment and systems have been observed to operate at significantly different levels of productivity. This has generally been attributed to the differences in fundamental management and labor practices. Good relations between management and labor are an essential prerequisite to introducing productivity improvements successfully into the workplace. It is in this area especially that large gains can

are not new. They have been tried successfully in other industr
and have even been introduced into portions of the marine termi
industry.

Particular labor-management practices with potential to i
prove the productivity of marine terminal operations are describ
in detail in the workshop report, "Issues in Improving Product
ity" (in this volume). These practices include:

- *Employment Continuity* Employment continuity can b
efit both marine terminal operators and terminal workers.
permanent employees, terminal workers have the opportunity
learn a skill or the intricacies of a particular job to an extent t
increases their worth to the employer. In exchange for a m
skilled and knowledgeable employee, the terminal operators
fer job security and possibly higher compensation. Some of
practice is ongoing today but mostly among the highest ski
workers. A particular benefit of expanding this practice is t
it has great value in enabling or facilitating innovative change
the terminal over time.
- *Multiskilling* The longshore work force of today is a s
stantially more skilled body of people than those who worked in
industry before containerization. This higher level of skill has g
together with substantial increases in benefits for the work fo
However, this practice also has bred narrow specialties that de
the search for a low-cost operation. Broadening the skill of
terminal workers can create future benefits to both the oper
and the worker. Through training, terminal workers can acq
additional skills with additional pay. The terminal operator
reap the benefit of more effective use of the work force.
- *Flexible Hours* The marine container terminal is marke
very large surges in demand for service. These surges of unusu
high service demand could be ameliorated by providing service
a longer period of time beyond current contractual work ho
Changes in work rules that support more flexible operating h

have the effect of making a particular terminal more competitive and profitable. This should lead to more jobs or compensation or both for the worker.

- *First-Line Supervisors* First-line supervisors representing the terminal companies deal directly with the work force. Their strong performance can play a critical role in successful innovations to improve productivity in the terminal. Sometimes first-line supervisors are less trained, experienced, and compensated than the workers they are supervising. This can result in management abdicating its responsibility to supervise the work force. Upper management needs to direct greater attention to the problems of first-line supervisors in dealing with the labor force and in preplanning the work, as well as in improving productivity.

Achieving Mutually Supportive Labor-Management Relations

The manner in which the terminal management communicates with labor personnel is also very important, as is labor's recognition of the value of a viable terminal. Both sides must recognize the need for stable and long-term solutions. There are two basic avenues for communication between management and labor. One is through the collective bargaining process, another through joint labor-management groups.

The catalyst for achieving mutually supportive communications in many industries during the past several years has been the necessity to prevent the demise of the company or industry. Such dealings between management and labor have been along a rocky road because of the critical environment in which these talks have taken place. In the marine terminal industry, the need for improved communication is not yet driven by threat of a bankrupt work environment. Long before any such eventuality occurs, the needed communications could be generated and common objectives identified. A current stimulus for dialogue, which is starting to appear, is the shifting of cargo from one port to another or from U.S. ports to ports of contiguous foreign countries.

The foundation of the structure for starting this very difficult dialogue appears to be in place in spots. For example, on the West Coast of the United States, the mutual benefits to be derived from safety have generated formal and informal labor-management dialogue. Some companies have begun to hold so-called gangway

Prevention Committee to oversee and encourage safety dialogue. These mechanisms have all the earmarks of a start in constructive labor-management dialogue to improve productivity.

A Process for Improving Productivity

The marine container terminal industry is still in a growth mode. The wealth of information in this report and proceedings on improving productivity makes this a propitious time to formalize a process for improving productivity before the inroads of competition make this a distressed industry. Port authorities, shipping companies, stevedores, terminal operators, labor unions, shipping associations, truck and rail operators, and government agencies all have an interest and a role to play. Interested top-level officials should consider creating a structure within industry to address the common interest of productivity improvement in the marine terminal. A voluntary national committee of all elements of the industry on marine terminal productivity, facilitated by the Maritime Administration and possibly the National Research Council, could encourage, initiate, and oversee many efforts that are in everyone's interest, for example:

- the establishment of a profile of productivity measures (as described in this chapter);
- the standardization of automated container identification and terminal management information systems; and
- joint labor-management cooperation addressing the human resources aspects of improving productivity.

The efforts of this committee, and of all who have participated in the proceedings leading up to this report, should not be wasted. Many significant suggestions have been made. Many people have begun to believe that improvement, soon and without great expenditures, is possible. The effort should be continued until improved productivity has been achieved in the marine terminals of the United States.

Part 1

WORKSHOP REPORTS

MEASURES OF MARINE CONTAINER TERMINAL PRODUCTIVITY

A marine container terminal is a complex facility that involves a variety of different parts and processes. The physical plant consists of berths for ships, cranes for transfer of containers between the terminal and the ship, yards for storage of the containers, gates for entrance, exit, and checking of containers, several other smaller subdivisions for equipment, and administration. The processes involved include checking the containers through the gate (in both directions), stuffing and stripping, transporting containers between gate and storage areas and between the storage area and the cranes, and hoisting the containers on and off the ship.

In the United States today there exists a large number of container terminals, the total capacity of which exceeds that required to handle the current level of trade. This situation results, in part, from the fact that many local and state governments have encouraged the development of their ports through a variety of subsidies. Selection of a particular terminal by a shipping line results from considering a multitude of factors, including the terminal charges, the turnaround time for the ship, the nearness of the terminal to the container shippers or receivers, the convenience of the terminal to the hinterland infrastructure (road, rail, feeder shipping), and

Workshop participants are listed in Appendix D.

and to a certain extent the shipping line and the truckers who use the terminal as an interface. The remaining factors, although very important to the success of a terminal in attracting business, are the result of geographic location, weather, historical accident, demographic factors, and the like. These factors are not addressed in the following discussion of terminal productivity, since they do not represent features that can easily be modified by the interested parties.

The focus of this report involves, therefore, only the measurement of productivity of the terminal itself. Measurement is the first step in management, since it provides the necessary yardstick for assessing both performance and improvement. Productivity measures are traditionally formed as the ratios of two quantities that generally reflect an input to a process and its output.

In industry either the input or the output is often measured in monetary terms, since profitability is an issue. Labor is a principal component in the cost of operating a terminal. Wide variations of labor costs exist across the United States, and even larger variations exist when compared with labor costs abroad. It is fair to say that most of the parties involved in container terminals use such cost measures in their daily business, although there is no unanimity on which measures are the most appropriate and, under any circumstance, these measures are considered highly proprietary.

Approaches that involve actual costs have not been adopted here. Efficient operation of a terminal is presumed to require certain labor, land, and equipment resources independent of these local variations. The point of view here is that productivity measures that are ratios of two physical measurements can reflect the efficiency of the process without the need for addressing local costs. As such, these measures should have broad applicability both here and abroad.

Finally, any measure of productivity should be selected on the basis that it is unambiguous, easy to measure, and sensitive to the most critical part of the operation it addresses.

THE ELEMENTS AND CONSTITUENCIES INVOLVED IN PRODUCTIVITY

marine terminal involves a variety of different processes in :ar or pipeline arrangement. Each process is crucial to the quent process, and the productivity of each depends not only ; intrinsic ability to perform the process, but on the interface the other processes as well. For instance, a slow loading rate ıtainers on board a ship could be the result of limitations of articular crane, of poor delivery of containers to the crane, :essive heel of the ship, or of other factors not related to the or its gang.

.e major elements in the terminal operation on which one can on productivity are:

The Container Yard Unlike the traditional finger pier and ge shed operation, which characterize break bulk operations, .tainer terminal requires an expanse of flat land for tempo- container storage. If a broad expanse of land is available, it may be possible to stow individual containers on wheeled is; if the land area is small it may be necessary to stack the .iners, two, three, or more high. The movement of containers :ontainer yard requires very different equipment for a chassis .tion than for a grounded or stacked arrangement, and the :ncy of this part of the operation reflects these differences. rally speaking, the larger the land available, the easier it is to de efficient land operations within the terminal. On the other , if the shape of the land is something other than rectangular, this geometry may adversely affect the yard performance.

The Cranes The cranes are the single most expensive piece echanical equipment used in a container terminal. These sticated pieces of machinery have been developed to pick up .iners from the dock and place them onto a containership :ntly, or vice versa. Because as many as three or more of units may work a ship simultaneously, it is important for ıctivity for these cranes to perform well. Crane delays can be d by a variety of factors including the appropriate container assis not being available for the next cycle, the requirement ıe crane operation to be stopped during coning or lashing, rane driver capability and experience.

the labor productivity is dependent on a variety of other fac
including the organization of the terminal (both physically
administratively), the age and operability of the equipment,
the weather.

4. The Gate The gate represents a significant part of
terminal operation in that it controls the flow of containers in
out of the container yard. A typical outbound loaded contain
weighed and inspected for damage, and the shipping docum
checked. This process can take either a matter of minutes or
than an hour, depending on the problems encountered. To pre
the gate from being a bottleneck in the flow through the conta
terminal, most terminals are equipped with extensive hard
such as computers or television cameras (to aid in the inspect
Most terminals have multiple lane gates so that delays in one
need not slow down the overall terminal operation.

5. The Berth The berthing facilities generally provide
ship with adequate draft, docking space, and equipment fo
ship to be loaded and unloaded. As a result, the berth doe
directly govern the productivity of the terminal per se. How
the preparation of the berth (including construction of the
and dredging) is extremely expensive, and indications are t
greater share of these costs will be borne by the ports in the fu
These costs, since they are associated with operations, are l
to be passed on to the terminal.

The factors affecting any process in the chain of terminal
cesses are usually very different from those in the next pro
More importantly, the constituency responsible for each s
resources is usually different from those responsible for others
creases in productivity in one process may negatively affec
productivity in another. Each of the parties involved in th
of, or the operation of, a marine container terminal, there
has a very different view of productivity. It is useful to list
constituencies and to describe their principal concerns:

1. The Ship Operator Because of the very high capital cost of the ship and the need to maintain a regular schedule, the ship operator's principal interest is in minimizing his time in port. The ship operator's customers are sensitive to the total transit time. Consistent delays in the terminal that increase the total transit time may make the ship operator less competitive compared to another ship operator using a different terminal.

2. The Port The port may own the space that the terminal occupies, and it usually has many goals. Usable land space is a scarce commodity, and modern container terminals require a significantly larger amount of space than the storage sheds previously used in break bulk cargoes. As a result of the national concern for the environment, traditional methods for creating new lands using landfill are restricted, and the filling process, if allowed, is carefully monitored. The port would like to allocate this limited space to optimize its income. In addition to the efficient use of its resources, most ports are part of local or regional governments. These governments often perceive the port as a provider of jobs to the community and, indeed, even as an important symbol of the size and status of the community. Thus, the use of labor-saving innovation may not be attractive to the port. In addition to the land usage, a port will be interested in the berths, since the dredging required to maintain the draft at the berth and in the access channel is expensive, and these costs will more and more be borne by the ports.

3. The Terminal Operator and the Stevedoring Company Often only one body performs both operations of terminal operation and stevedoring. Although situations exist where the two are separated, they are considered here as a single constituency, simply referred to as the terminal operator. The personnel who operate a marine terminal are paid by the terminal operator, and the productivity of these employees is a prime consideration of the terminal operator. In addition, the terminal operator may be financially responsible for some of the major equipment (such as cranes, the gate equipment, straddle carriers, and the like) and is, therefore, particularly interested in the efficient interaction between these machines and the terminal personnel.

4. Labor As a constituency, labor is interested in obtaining full employment and in obtaining a high compensation for its workers. Often labor sees an emphasis on productivity as directed

competition from foreign ports as well as among domestic ports, and with nonunion ports appearing, the issue of labor productivity is again brought into question.

5. *The Truckers* The productivity of the front end of the terminal directly affects the truckers. Delays in going through the gate or in delivering or picking up a container can adversely affect the efficiency of a trucking operation. Most containers are delivered to the terminal from local locations, either from the originating shipper or from a railroad terminal. In this short-haul drayage operation, gate delays of an hour or two can dramatically reduce the number of hauls per day. This inefficiency is ultimately reflected in the total freight charges and may also affect the competitiveness of the port.

A PROFILE OF PRODUCTIVITY MEASURES

As a result of the variety of different elements and different constituencies involved in determinating the productivity of a marine terminal, there do not appear to be any two terminals whose situations are so similar that they can be called equivalent. It is clear that any single measure of marine terminal productivity would not be able to take into account all of the important facets that affect a marine terminal operation. Each terminal has a unique situation involving a different site and different labor arrangements. In short, each marine terminal must optimize its own operations with respect to its niche in the marketplace.

In order to make sense out of this situation it is helpful to consider a profile of productivity measures, which would comprise a collection of individual productivity measures, each of which addresses a particular important aspect of the marine terminal's operation. If correctly chosen, the combination of all of these measures would display how a particular terminal is being operated, and give considerable insight into the efficiency of the terminal. One anticipates that in such profiles port A, say, will show some

measures better than and some measures worse than port B. Except in the rare case when all of the measures of one port are either better than or worse than another, the profile of productivity measures will not give a global answer that one port is either better than or worse than another.

The following measures focus on the most important aspects of a marine terminal:

1. The Crane Two measures of productivity related to the crane are proposed, addressing different aspects of the crane operation. These measures are:

$$\text{Net crane productivity}: \quad \frac{\text{moves}}{(\text{gross gang hours} - \text{downtime})}$$

and

$$\text{Gross crane productivity}: \quad \frac{\text{moves}}{(\text{gross gang hours})}.$$

In these measures a "move" is defined to be an exchange of a container between the apron and the ship. Rehandles on board ship do not count, and empty containers are treated the same as loaded containers. Furthermore, a move for a 20-foot container is the same as that for a 40-foot container. That is, for this measure there is no distinction between TEUs and FEUs.* "Gross gang hours" is the gang hours paid for and includes the time that the stevedoring gang and the ship are mutually available. "Downtime" is time that the crane is unavailable when required for operation due to any cause, such as breakdown or other delays.

The net crane productivity measure reflects the ability of the crane and crane driver to work a ship when the loading process is limited by crane productivity, whereas the gross crane productivity measure reflects the crane activity, including all of the delays due to mechanical reliability, the ability of the gang to supply the crane with loads, and their ability to remove the discharged containers from the crane. The net productivity is principally influenced by:

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* TEUs and FEUs are measures of the capacity of container ships and terminals. The terms refer to the numbers of 20- or 40-foot-long containers or their equivalents capable of being transported, handled, or stored.

Typical factors reducing gross crane productivity are:

- breaks in yard support;
- crane and spreader breakdown;
- unavailability of required freight for loading; and
- delivery from yard in wrong order.

These measures of productivity can have many uses in improving productivity including:

- comparison between ports with similar operating conditions;
- comparison between cranes in one terminal;
- jawboning during union contract negotiations;
- benchmarking for evaluating new operating schemes; and
- a basis for incentive schemes.

2. The Berth One measure of productivity of the berth is proposed:

$$\text{Net berth utilization}: \quad \frac{\text{container vessel shifts worked per year}}{\text{container berths}}.$$

In this measure a berth will typically involve a quay and apron of about 1,000 feet and will serve average container ships of 700 to 1,000 feet long. The vessel shifts are not the gang shifts, since there may be good reason for the ship to occupy the quay without being worked.

The net berth productivity can be interpreted as a form of a berth use, since the number of available vessel shifts per year is fixed. A high value of the berth productivity (i.e., a high berth use) may reflect a high income of these facilities for the port and perhaps berth availability delays for the ship. As a result both the port, which bears the great expense for the design and construction costs for the berth, and the shipping line are interested in the berth productivity, but for very different reasons.

Berth productivity is influenced by a wide variety of factors including:

• vessel scheduling. A nonuniform arrival and departure pattern reduces berth productivity.

• number of moves per call. Increases tend to increase berth productivity.

• length of berth. A long, multiberth terminal can achieve higher productivity through flexibility of docking.

• cranes per berth. Increasing the number of cranes can reduce berth productivity by servicing the ship faster. Alternatively, more cranes can permit more ship arrivals and actually increase berth productivity.

• operational practices that may discourage full use.

The net berth productivity can be used by the port to determine if it needs to construct new berths and by the shipping line to estimate potential berthing delays.

3. The Yard Two measures of productivity related to the yard are proposed:

$$\text{Yard throughput}: \quad \frac{\text{TEUs/year}}{\text{gross acre}}$$

and

$$\text{Yard storage productivity}: \quad \frac{\text{TEUs capacity}}{\text{net storage acre}}.$$

In these measures a TEU is used since it defines a footprint area. Thus, an FEU is equivalent to two TEUs for this purpose. The gross area includes branch roads for the equipment, parking lots for equipment and yard operations, space for control buildings and associated equipment (such as lighting poles), reefer area, and inspection areas. The net storage area includes only that part of the yard that can actually be used to store containers and includes access roads and safety areas. The capacity of the yard is based on the maximum possible storage slots, with each slot filled to the maximum stacking height.

The yard throughput productivity reflects the ability of the yard to transfer containers through the yard to the ship and vice versa. The yard storage productivity is simply a measure of the density of the storage system. In a sense these two measures are in opposition, since an operating system (such as a chassis operation)

- type of equipment;
- operational layout and physical size of the yard;
- management, including communication terminal and quality of the information;
- labor skills and motivation; and
- overlap between quay-side and land-side operations.

The factors that influence both yard throughput productivity and yard storage productivity are:

- storage height and mode of operation (chassis, straddle carriers, and stacking crane);
- the spacing between ground slots both in length and width directions; and
- required safety areas.

These measures of productivity can be used by the terminal operator for:

- expansion planning;
- benchmark for area use; and
- production guarantees.

They can be used by the port for:

- monitoring the profit per acre of facility and
- assessing the growth potential.

4. The Gate Three measures of gate productivity are proposed:

$$\text{Net gate throughput : } \frac{\text{containers/hour}}{\text{lane}},$$

$$\text{Gross gate throughput : } \frac{\text{equipment moves/hour}}{\text{lane}},$$

and

$$\text{Truck turnaround time} : \frac{\text{total truck time in terminal}}{\text{number of trucks}}.$$

In these measures a lane refers to a manned lane rather than the physical number of lanes at the gate. Equipment moves include all moves through the gate that require gate action (for equipment such as containers, chassis, and bob-tail tractors). Truck turnaround time, although it is not a formal productivity measure (i.e., not a ratio of an input and output), is included in these measures because it plays an important role in the teamster cost. For the purposes here it is taken to be the average turnaround time experienced excluding the 5 percent slowest turnarounds.

The net gate throughput productivity measures the ability of the gate to pass revenue freight through, whereas the gross gate throughput productivity reflects the ability of the gate to handle the volume of required traffic. Factors that influence both of the throughput measures and the turnaround time are:

- modal mix including
  (a) ratio of incoming to outgoing containers and
  (b) ratio of truck to rail hinterland transport;
- vessel schedules and vessel capacity;
- customs regulations;
- vehicle safety and other inspection and repair requirements;
- presence of proper paperwork;
- communication skill of gate employees and drivers;
- level of automation; and
- the presence of off-dock facilities such as a container freight station (CFS) and equipment storage.

These measures can be used in improving productivity by providing:

- comparison between other similar terminals;
- a benchmark for evaluation of the number of manned lanes; and
- a tool for assessing if the gate is a significant bottleneck.

5. *The Gang* One measure of productivity of the gang is proposed:

must be placed on the apron before restowage. The man-hours include all direct labor involved from the stevedoring component to the yard support personnel directly associated with the loading of the ship. These include crane operators, toploader or transtainer operators, and others. It is envisioned that both terminal operators and labor will use this measure to judge the effective use of stevedoring manpower.

The factors that influence the gross labor productivity are:

- amount and quality of management preplanning;
- effectiveness of supervision including communication skills and information flow;
- skill, experience, availability, and training of the work force;
- required gang size;
- work rules and safety requirements;
- type of operation (chassis, stacked, and so on);
- vessel size and characteristics including
  (a) mix of 20- and 40-foot containers,
  (b) number of ports of call on itinerary,
  (c) special handling requirements, and
  (d) type of lashing;
- efficiency of ship storage plan; and
- vessel operator's policy on accepting last minute deliveries.

This measure can be used in several ways to increase productivity, including:

- comparison with similar terminals operating under different unions and work rules;
- jawboning during union contract negotiations; and
- providing a benchmark for incentive programs or for new operating systems.

USING A PROFILE TO IMPROVE PRODUCTIVITY

These nine measures are an extensive, but by no means com-lete, set of possible productivity measures for a marine container erminal. They do, however, provide a fairly good overall view of terminal operation when taken in the aggregate. As mentioned efore, many of these measures are in opposition to one another. 'hat is, changes in either the terminal operation or layout that nprove one measure may, and likely will, worsen another. It is the lassic responsibility of the terminal management, in concert with he port, the truckers, and labor to balance all of these factors in uch a way that the terminal is viable and prosperous.

Although these measures may be useful to each individual port ı examining its own activities, their usefulness would be greatly nhanced if comparable information were available from a number f different terminals, both around the country and outside the ountry. The availability of this information would provide a firm asis for comparison between ports. For this reason, the proposed neasures of terminal productivity were not expressed in terms of ost and were kept to the smallest number that would adequately haracterize a terminal's activity. In this way the burden on the erminal or port reporting these measures would be minimized.

It is likely that in comparing two ports, some of the measures rom one will be better and others will be worse. Each of these neasures is influenced by a considerable number of factors that ary from terminal to terminal. For a comparison to be mean-ngful requires a detailed examination and analysis of all of the nfluencing factors. This analysis can provide an important basis or evaluating changes in either procedures or equipment for use n the terminal.

The issues in improving the productivity of U.S. marine terminals were sorted into three broad categories to facilitate analysis, although there is considerable overlap and interaction among the categories. The implementation and use of state-of-the-art technologies or promising technologies currently being developed, which will require significant capital expenditure, is one category. Incremental operational or management improvements that do not require major capital investment is the second category. The third category includes the full range of human relations issues from the most obvious questions surrounding organized labor and the collective bargaining process to the more subtle questions of the effectiveness of first-line and middle management, and the role of management perceptions of organized labor in shaping management decisions regarding technological change. These issues were the most difficult to address and appeared to have the most influence of the three categories considered, yet they hold the most promise for productivity improvements, both directly and indirectly, by means of facilitating the introduction and use of other productivity measures with or without massive capital investment.

Workshop participants are listed in Appendix D.

NEW TECHNOLOGIES REQUIRING MAJOR CAPITAL INVESTMENT

The implementation and full use of state-of-the-art or promising echnologies, which will require major capital investment, may be riven by the need to be more productive and cost-effective, and to rovide better service. In these instances, new facilities are likely be constructed at or near existing terminals. Alternatively, ne impetus for new facilities may stem from a need to relocate terminal because of congestion or access problems, limitations n available land for cargo handling, or competing pressures to onvert port lands to other uses.

It need hardly be stated that investments in new technolo-ies and facilities are not made in a vacuum. Certain aspects of ne larger operating environment need to be kept in mind when onsidering issues attendant to investing in new technologies and acilities.

• *New Technology Will Come* Regardless of labor-manage-ment considerations, the possibility of industry overcapacity, cap-al limitations, or other factors that would appear to mitigate gainst some forms of investment, new technology will be intro-uced into the U.S. marine terminal industry. The challenge is to ntroduce it as effectively as possible, given the limitations.

• *Capital Is Limited* Particularly in the near term, the cap-al resources available for new technology introduction will be mited. Some private terminals and public port authorities are acing severe limitations in the highly competitive environment of oday. State and local agencies are being more selective in pro-iding public port subsidy funds in view of broad governmental udgeting problems. New bond issues are facing a more difficult nterest rate environment because of changes in federal tax law.

• *The Labor-Management Environment Inhibits Full Benefits f New Technology* The current labor-management operating en-ironment, which (most particularly on the East Coast and Gulf Coast) is better characterized by the adjective "competitive" than cooperative," has not impeded the development and application f most competitive technology. However, longstanding labor-nanagement agreements have denied much of the cost-saving ben-fits of new technologies to the terminal operators. Until there

may come from other industries, which contribute container identification technology or material han technology. It may come from other countries that have alr built highly advanced marine terminals. Or it may come fron interaction with other transportation modes through interm ism. New technology may also come through lateral transfer other new facilities within the U.S. marine terminal industry. main point here is that many forms of new technology that c be applied to improve productivity of marine terminals alr exist and are directly applicable today.

Several state-of-the-art technologies (described in the inv papers presented at the meeting and included in the proceedi that are in use in some marine terminals here and abroad considerable productivity improvement benefits. These are:

- infrared data transmission systems;
- double-trolley container cranes;
- multitrailer systems; and
- integrated terminal design and operations.

In addition, there are a number of emerging technologies t hold promise for productivity improvements. Among these are

- automated trim and list control systems;
- cell guides for container stowage on deck;
- semiautomated or fully automated cranes;
- buffer systems to decouple major equipment and reduce de time;
- chassis guide systems to speed container placements;
- passive and active/passive equipment identification systen
- automated container storage and retrieval systems;
- automated guided vehicles;
- voice recognition technology for equipment commands a data entry;
- hand-held interactive computer terminals;
- advanced rail car and chassis designs;
- stowage planning systems;

- decision-support computer models;
- networking and data-base management systems; and
- crane simulators and operations simulators for planning and rsonnel training.

In the future, a top priority in new technology introduction ould be in the general area of information management, since tter information flow can achieve more productive cargo flow en with existing handling facilities. A particular area of oppornity now being addressed by the Cargo Handling Cooperative ogram (CHCP), a cooperative technology development program onsored by the Maritime Administration and U.S.-flag carriers, for an accurate and dependable container identification system at can be compatible with location-sensing devices.

Overcapacity of container facilities is a problem. The enormous vestment in container facilities over the past 30 years has led overbuilding, with consequent overcapacity and underutilizaon. Interport competition, and the desire to employ the latest chnology as an adjunct to marketing efforts, may further this end. The marine terminal industry needs to employ economic alysis tools, modeling techniques, and other decision-support ethodologies in order to test decisions properly regarding new chnologies and new facilities, and to direct investment to those chnologies with the highest potential profitability.

Those who invest in marine terminal technologies should take count of certain factors:

- Increased standardization in the industry, especially in coniner identification systems, sizes, and documentation, will conibute to most efficient investment and improved productivity.
- Each investment in new technology or new facilities should e evaluated in light of the total transportation system of which is a part.
- A mechanism for industry-wide cooperation in developing, lapting, and proving technologies for marine terminals would be ry useful.
- Some form of rationalization of the capital expenditure process would be desirable to prevent or reduce redundancies in capal development programs.

As elaborated elsewhere, labor needs to be involved in the entire rocess of technological change to ensure worker acceptance and to

the terminal worker, whether in the yard or in the office, is an integral partner in the successful operation of a marine terminal. Management has to take the needs of workers into account, especially in the areas of safety, environment, and worker satisfaction. For its part, labor needs to adopt a cooperative attitude and to demonstrate a real interest in improving productivity.

INCREMENTAL OPERATIONAL IMPROVEMENTS NOT REQUIRING CAPITAL INVESTMENT

Several incremental improvements can be made in marine terminal operations that will improve productivity with little or no investment. One way of locating opportunities for productivity improvement is to conduct a systems analysis of overall terminal operations, including not only the activities within the terminal boundaries, but also the arrival and departure activities of vessels as well as trucks, trains, and barges. A container terminal simulation model under development by U.S.-flag carriers through the CHCP provides a valuable first step in this regard. Such an analysis will help to focus attention on bottlenecks and on areas where cargo flow capacities are not in balance. Such analyses should study both the flow of cargo and the flow of information. Even when changes in work organization are indicated, much can be accomplished within the framework of existing labor-management agreements, provided there is cooperation and understanding among the parties involved.

Outside the Terminal Boundaries

Once a ship enters a port area, its ability to reach a terminal in a timely and reliable manner will affect the productivity of the terminal. Efficient operations of tugs and pilots in a port area will be a valuable aid to terminal operations. In a similar manner the ability of vehicles (i.e., trucks, trains, and barges) to carry

rgo to and from the terminal will also influence the terminal's oductivity.

Gate Operations

A variety of approaches can be used to improve the produc- vity of gate operations. A cost-benefit analysis can be made ncerning the inspection of equipment. It may be cost-effective perform thorough inspections—and make corresponding entries the Equipment Interchange Report (EIR)—only when major uipment damage exists. Where local circumstances indicate, nsideration should be given to separate in-gate lanes for special rposes (empties, bare chassis, high-volume movements, and in- rmodal land bridge movements). Also, operational procedures n be revised to incorporate a quick precheck of documentation— eeding out early those with incomplete documentation. Some rminals already use these types of gate arrangements with good sults. Inexpensive hand-held computer terminals can be em- oyed effectively to quickly capture critical information. In addi- on, where practical, incoming and outgoing gate lanes should be terchangeable to accommodate heavy traffic flows, along with angeable directional signs and markings. Extended and flexible erating hours would also contribute to more efficient use of fa- lities and vehicles. Separate and multiple scales may also speed te operations.

Other Terminal Operations

The layout of the terminal can have a major impact on pro- ctivity. Preplanned traffic flows, including express lanes, should provided to allow relatively unrestricted movement between rking slots or container stacks and the shoreside cranes. Traffic tterns in the terminal should be designed and well marked to itigate peak period congestion problems, especially when several erations are being conducted simultaneously.

Carefully planned parking areas for equipment can aid produc- vity. A simple parking system should be incorporated in the esign for fully wheeled operations. Installing high-visibility, row- mber signs and pavement markings could facilitate traffic flow d eliminate confusion for tractor drivers.

this way, one tractor can pull up to five chassis-mounted contain-ers. (Even longer yard pulls are employed in at least one European terminal.) The benefits would include reduction of tractor trips between stack and ship, fewer tractors needed, and a decrease in the number of tractor drivers required.

Decreased productivity in cargo handling can be caused by delays and congestion in the handling of information. A terminal operator should consider the standardization and consolidation of documents so that all documentation functions can be handled at one processing point. A good deal of documentation deals with inspection activities of federal agencies (e.g., Customs, Transportation, or Agriculture). If these different functions could be unified into a single activity, it might be possible to increase the productivity of both the federal agencies and the terminals.

A change in terminal operations policy could also increase productivity. Terminals typically receive cargo up to the last minute before sailing. Such an occurrence requires juggling of boxes and extra effort to handle the unexpected cargo. If a terminal had strict cut-off times to allow systematic planning for cargo handling, there would be fewer surprises and increased productivity. The difficulty with this idea is that if only one terminal or ocean carrier adopted this practice, others would gain a competitive advantage. Therefore, strict (and reasonably early) cut-off times would work best if all the terminals in a port area, or all the ocean carriers on a particular trade route, jointly adopted this strategy.

IMPROVING LABOR AND MANAGEMENT PERFORMANCE AND RELATIONS

Marine terminals may operate at different levels of productivity even though they use comparable equipment and systems and employ similar work practices. These differences arise in part because of site-specific variations, but labor and management practices are also an important factor.

Opportunities for productivity gains as the result of improve-ents in labor and management performance and relations lie the general areas of management practices, work-rule changes, ıproved use of labor under existing work rules, union hiring pro-dures, and improved training. For these gains to be realized, l parties need to be innovative in their approach to the issues, ıoperative in their attempts to solve problems, and respectful the interests and viewpoints of the other parties. Thus, there e two elements to improvement. The first is identifying specific ıanges in labor and management practices, which are desirable ecause they show promise (primarily from experience in other dustries or elsewhere) of improving productivity. The second is :hieving mutually supportive labor and management relations, obably based on shared objectives such as improved economic :tivity in the port, which enable changes to occur.

Innovative Labor and Management Practices

This section sets forth several innovative steps that might be ken. None of the steps, in and of itself, is a panacea. There e vast differences among terminals. No one approach to human lations issues can be universally applied. However, steps such those described here have been helpful in situations where the troduction of new technologies into the work place has neces-tated rapid advances and accommodation by both management ıd labor. Examples of this in other industries abound, including veral in the maritime industries.*

mployment Continuity

Productivity improvements may result from increasing the num-er of laborers who are employed on a continuing rather than ca-ıal basis. There is already a considerable amount of steady em-loyment in the skilled trades. Particularly in the skilled trades, ımiliarity with equipment and procedures as well as better em-loyer identification can lead to better productivity. Employment

National Research Council. 1984. Effective Manning of the U.S. Merchant leet. Washington, D.C.: National Academy Press; National Research ouncil. 1982. Productivity Improvements in U.S. Naval Shipbuilding. /ashington, D.C.: National Academy Press.

always lead to better productivity. This type of change ma
its greatest value in supporting or facilitating other more i
tive changes.

Multiskilling

This change refers to the practice of reducing the numbe
classifications so that a given worker may work at two o
separate jobs on different shifts or even within the same
circumstances so dictate. To be effective, multiskilling n
be accompanied by training to ensure that workers are p
trained for each job within their classification and that each
can do each job efficiently and safely. A potential concer
multiskilling is that workers might evolve into jacks-of-all-
but masters of none. To avoid this, and in the interests o
and effectiveness, job classifications need to be chosen carefu
not made overly broad. Unions are concerned that multi
can lead to fewer jobs (and lower union membership).

Flexible Hours

More flexible work hours could lead to greater producti
the marine terminal and in the connections to the other tr
modes, particularly trucking. The current, relatively rigi
schedules in some terminals can lead to excessively long
times for trucks, especially in the periods near shift change
costs associated with long turnaround times for trucks
always be the direct concern of a terminal operation, sin
affect the overall efficiency of the total intermodal transpor

Strengthening First-Line Supervision

First-line supervisors are the interface between labor an
agement. The quality of their performance reflects the s
from and integration with middle and upper managem

as the quality of labor-management relations in the termi- Many in the work group were concerned about the need for rovement in first-line supervision.

ome felt that many companies have abdicated first-line man- nent responsibility to union foremen and have left the first-line iagement personnel with an undefined or poorly defined role. t-line supervisors are frequently undertrained and not ade- tely supported by upper management either in their dealings 1 the labor force or in the planning and preplanning of the k. Concern was also expressed that many, if not most, first- managers in the marine terminal industry are not sufficiently ipensated relative to the responsibilities of their position or tive to the compensation of the workers they are charged with ervising. Improvements in first-line supervision are especially ical to effective management in the introduction and applica- of new technologies.

imary

'hese and related steps could improve productivity at current ls of technology and investment. Furthermore, in other indus- s, they have been especially helpful in supporting and managing introduction and application of new technologies in the work- :e. If such measures are successful, then the result may increase k opportunities in a terminal or port. However, there is also possibility that the increased efficiency that results from im- ving productivity will lead to reduced demand for labor. The orical trend in longshore employment as the industry switched n breakbulk to containerized general cargo is clear. No one ws whether a trend of similar magnitude will accompany the t generation of marine terminal technology.

'he problem of work force reduction due to technological change vork-rules change is especially difficult. Progress in this area require labor recognition of management concerns in the ar- of productivity and competitive position, and management ɔgnition of labor concerns in the areas of work preservation worker income. Both must recognize the need for stable and g-term solutions.

\ number of longshore collective-bargaining agreements contain visions for income or job guarantees when workers are displaced

by cooperatively addressing these problems with a view ... equitable and efficient long-term solutions.

Achieving Mutually Supportive Labor and Management Relations

The stimulus for innovative steps in human relations ... positive or negative. In some cases, a terminal or port m... an opportunity for increased business or improved profi... and the stimulus for change could be the possibility for in... throughput at no additional investment for management ... creased work opportunity for labor. In other cases, a p... terminal may face intense competition and need to respon... better productivity, lower costs, and better service in or... retain or regain cargo. Alternatively, the need for port p... tivity improvement may be triggered by the possibility of ... technological change. Whatever the stimulus, the types of ch... addressed in this report are most effective when both sides ... nize that a need for change exists and desire to bring about c... in an equitable manner.

Many of the innovations discussed in this report require sp... circumstances and care to be applied. Each change has ... tailored to the situation in question, taking into account the ... of terminal, its competitive position, the region of the cou... and, of course, existing collective-bargaining agreements. Ta... all of this into account, these innovations (and those that fol... are completely compatible with collective bargaining, as has ... demonstrated in many other U.S. industries.

Sometimes it is possible to reach agreement on proposed cha... between management and labor leadership more easily than ... possible for labor leadership to communicate the need for s... changes and the implications to union members. Management ... have to support labor leadership in this. A particularly valua... insight in this regard is that fear of the unknown can be a ma...

impediment to worker acceptance of new concepts. The opportunity to witness the new concepts and discuss them with workers who know them can help overcome such fears. Management can provide the catalyst for this by arranging for representative groups of workers to visit other terminals in this country or abroad, where the work rules or technological changes in question are already in place.

Joint labor-management committees at the work site might offer a more continuing basis for discussing problems and potential changes and their implications. In the current context, how work practices affect productivity would be a major topic of discussion. Other topics that typically benefit from mutual exploration are workplace safety, training programs for advancement, training programs for outplacement, first-line management issues, long-range plans for facilities improvements or new facilities construction, and means for dealing with substance abuse. Joint groups might also serve as points of contact with users of marine terminals such as shipping lines, railroads, or truckers in order to give workers firsthand knowledge of how their work affects others. Cooperative labor-management activity can be most effective when it extends beyond the top levels (terminal management and union officials) to joint efforts by first-level management and longshoremen in the form of task forces and problem-solving groups.

While these innovations are compatible with collective bargaining, the impetus and suggestion to change labor and management practices may come to the forefront either within or without the collective-bargaining framework. Regardless of their origin, trial changes, mutually agreed upon, ought not to be allowed to interfere with other contract provisions. Safeguards to this end are desirable. Safeguards can take the form of an enabling agreement such as a contract provision, a side letter of agreement, or a noncontractual letter of understanding stating objectives and ground rules.

Sometimes proposed changes are substantial departures from current practice. Both management and labor may have an interest in gathering limited experience on how a particular new technology or work practice innovation would affect operations and productivity at a specific job site. In this event, marine terminal management and labor can take a cue from other hard-pressed

lishing and analyzing the results of trials. Where changes are substantial departures from past practice, it may be helpful to set up shelter agreements that protect both the integrity of the innovations to be tried and the basic interests of management and labor.

IMPLICATIONS OF TECHNOLOGICAL AND OPERATIONAL FACTORS FOR COMPETITION AND TRADE

he implications of marine terminal technological and opera-
al factors for U.S. competition and trade were appraised by ad-
sing the following issues in a way that identified their relative
ortance and areas requiring further study, so that impediments
arriers to improving productivity would be identified.

)omestic Technology and Engineering

. Is there a demonstrable link between technology and design and productivity?
. What, in general, is the state of the art in the United States? Is it improving?
. What can be said about the rate of productivity growth? Is there a role for research and development (R&D)?
. Are we "farming as well as we know how to farm?" What are the impediments, if any?
. Are there significant differences among U.S. ports? Can they be related to differences in technology and design or other factors?
. What is the role of the competitive balance between inland modes of transportation? What is the state of their technologies?

'orkshop participants are listed in Appendix D.

3. What is the state of the art among U.S. trading partners and competitors, including their infrastructure?
4. What can be said about their productivity and its growth rate?
5. In what ways do foreign ports and terminals compete with U.S. ports and terminals?
6. Does government abroad play a different role in the development of technology and design? What impact, if any, does this have?

C. Capital, Labor, and Management Requirements

1. How do America's basic inputs of capital, labor, management, and labor-management relations measure up?
2. Is there an appropriate balance between the cost of labor and the cost of capital? Do new investments create jobs or eliminate them?
3. What are the impediments, if any, to the flow of capital?
4. How is labor productivity tied to overall results? Is it improving? What are the impediments, if any, to productivity growth?
5. Is there a white collar productivity problem? Are we managing information well?
6. What is the general state of labor-management relations at home and abroad?

D. Implications for Import and Export Trade

1. How does marine terminal technology and operation affect U.S. import and export trade?
2. Who are the customers of general cargo marine terminals? What choices do they have in the marketplace? What are their needs?
3. To what extent do inland transportation options dictate marine terminal technology and operations?
4. Just how important is marine terminal productivity in making the United States an effective international competitor?

5. How can the marine terminal's customers' needs be more effectively met? Is there a relationship between quality and productivity?
6. Is there a role for quality technologies in marine terminal operation that could affect U.S. import and export trade?

PRINCIPAL FINDINGS

The differences between U.S. and foreign operations are more in degree than in kind. Any shortcomings in performance in U.S. terminal operations compared to foreign operations of similar capability are due more to the performance of people—management, dockside labor, and their organization and work practices—than it is to a need for new technological development.

There are no significant technological limitations at present that impede productive terminal operations. Most modern container terminal operators appear to be aware of and use the latest technologies when their use is cost-effective.

There do not appear to be any major new technologies just over the horizon which, if implemented, would provide significant productivity gains. The expectation that somehow technology can be used to make employees in U.S. terminals less of a controlling factor in productivity is not realistic. Even if there were some major technological innovations on the horizon, they would have little effect on the improvement of terminal productivity and revenues without first addressing the employees and their performance. The substitution of capital for labor does not promote economic efficiency because of institutional barriers.

In the case of middle management and much of the white collar activity in terminals, the same trends are apparent that are apparent in the rest of industry. Increased use of electronic data systems and other modern management techniques will greatly increase productivity and reduce personnel costs. This has been recognized by most terminal operators and is being accomplished.

Apparent productivity at some U.S. terminals has decreased since the introduction of modern container operations. This is due more to the increasing complexity of the modern terminal than it is to slower loading or unloading at the ship/terminal interface.

In examining the competitive nature of U.S. versus foreign terminal operations, where it exists, higher foreign terminal productivity and better efficiency are due to many factors, which may include geography, the market served, and the available infrastructure. Major positive factors where any advantage exists are generally associated with a more cooperative and hence favorable labor and management operating environment, and the high productivity that results. The role that foreign governments often take as a positive partner in the development of policy, capital formation, and the operational implementation of seaports is also important.

With respect to the question of whether or not poor terminal performance or productivity has an impact on U.S. import trade, it can be argued that the effect may be minimal with respect to trading partners who also have to use U.S. terminals. Poor performance does have an adverse effect where U.S.-based trade is competing with other trading nations to serve Third World export markets. In these trades, higher port costs put the U.S. shipper at a disadvantage. Additionally, nations contiguous to the United States can be the beneficiaries of unproductive or noncompetitive performance in nearby U.S. marine terminals through economically inspired cargo diversion.

In the context of this study, the work group concluded that technology should encompass machines, systems, and people. In short, productivity is a function of hardware, systems, and people.

Management of people in U.S. terminals ranges from good to very bad. Market forces have improved other portions of the transportation network outside the terminals. It is not clear in what way those market forces will eventually be applied to terminal operations. Current trends in other U.S. industries—such as the airlines, the auto industry, and seagoing labor—suggest that in time there will be some fundamental changes in longshore labor and management practices. The ingrained habits of several decades will be hard to change, harder in some places than others,

but change they will. U.S. import and export trade will be moderated by many factors, as noted before, but lack of technology is not a U.S. problem. Technology has been and will continue to be applied wherever economic efficiency can be achieved. The major impeding factor is the achievement of cost-effectiveness from better employment of people.

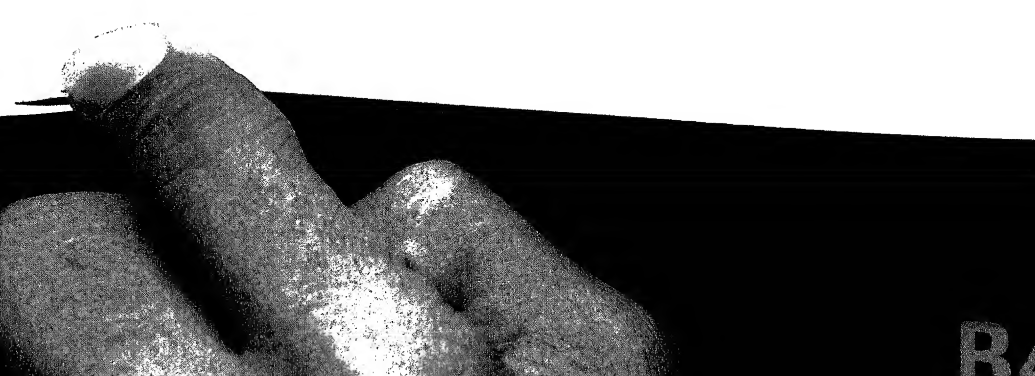
Temporizing factors that may apply to maritime industries, but perhaps do not apply to domestic segments of the transportation system, are government trade, political, and military policies. In domestic transportation modes, for example, productivity gains have been driven largely by market forces, resulting in substantial institutional rearrangements. On the international front, trade often takes a back seat to political and military considerations. Even in the matter of trade, governments may be prone to support or subsidize unproductive practices as matters of strategic concern. Those realities cannot be ignored.

Improvements in productivity of marine terminals may be amenable to improved techniques that involve performance incentives and concepts of self-management. Both labor and management have a part to play in improving productivity in U.S. container terminals. Both sides need to work together for the common interest.

B4

Part 2

SYMPOSIUM PAPERS



INTRODUCTION

JAMES H. McJUNKIN

'he Port of Long Beach is celebrating its seventy-fifth anniver- and is today the busiest port on the U.S. West Coast. This is ;ely due to the fact that the port recognized at the beginning he age of containerization that shipping in boxes would prove most logical way to increase productivity both in the shipping ustry and in marine terminals. Without pause for nearly a rter of a century, the port has created new land and new con- ier facilities, replacing breakbulk and antiquated facilities with ;e-of-the-art facilities geared to accommodate unprecedented wth in containerized cargo. In this effort, the port has been te successful. Fifteen years ago, the Port of Long Beach han- l about 40,000 TEUs per year. In 1985, the port handled a le over 1,100,000 TEUs.

lajor projects under way include:

1. The creation of a new 85-acre container terminal on Pier This has involved tearing down 5 warehouses and transit sheds

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'ames H. McJunkin is executive director of the Port of Long Beach, ifornia.

square miles of land seaward from the present harbor by the year 2000. Considering the enormous cost of dredge and fill construction in 50 to 60 feet of water, emphasis on productivity is essential to make these new facilities profitable.

The technological revolution in cargo handling of the past 25 years has caused cargo equipment to be improved to a remarkable degree. Perhaps the capability of today's equipment even outstrips the capability of management and labor to use it to its full potential. The next great revolution in the industry is likely to be directed to human relations and human resources. Now that we have extremely efficient equipment in place in our terminals we need to learn to increase productivity through better application of training and skills. We should not forget that it is our work force that has built our ports into their present position in world commerce.

The human relations revolution will be made up of a series of simple, straightforward innovations. The Port of Long Beach, for example, has recently begun discussions with the International Longshoremen's and Warehousemen's Union Local 13 to identify potential cooperative efforts in facilities development, the introduction of new waterfront technology, development of a safer working environment, and increased productivity. In other words, the port is working with the union as well as with management. Several years ago, the port created committees under its auspices to provide a forum for terminal operators, steamship lines, and others to discuss and work out solutions of various problems jointly. The port has also convened a series of terminal operations seminars, which have had hundreds of participants. On behalf of its tenants, the port has tried to improve the efficiency of U.S. Customs services. It has also brought terminal operators and the trucking industry together to address methods of easing gate congestion. These are the kinds of modest, incremental, problem-specific efforts that need attention.

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Thoughtful use of our highly skilled work force to cope with an ever-changing working environment should head our priorities. Without improvements in human productivity (management as well as labor), our sophisticated terminal equipment will continue to operate at only a fraction of its potential. This is a price the United States cannot afford to pay.

TERMINALS

RICHARD KING

The subject of this address is the competitive climate of international trade, the role of Pacific Basin countries in this competitive atmosphere, the role of the U.S. market, and strategies to maintain the U.S. competitive position in the home market. To cover this subject it is necessary to discuss as well the export and import factors that industries face, the tactics that foreign governments and companies adopt to compete, and trends in trade through the next 5 years.

TRENDS IN INTERNATIONAL TRADE

The international business environment is going to be far more uncertain and far more competitive in the future than it was in the past. Trade between the United States and its competitors in the European Common Market and Japan will grow much more intense; there will be more conflict and antagonism among

Richard King, who presented this keynote address at the symposium, is president of Richard King International, advisers to American and foreign executives on international business strategies, with emphasis on the Pacific Basin.

trading partners because of trade imbalances. Real trade imbalances will be compounded by political perceptions of unfair trade practices. Europeans and Americans in particular are entering an era of retaliatory practices. Some very important industries that affect marine terminal operations and affect my business as a consultant—for example, agriculture, aerospace, and computers—are going to have a tough time in Europe this year because of retaliatory trade practices.

There will also be increased friction in Asia and the Pacific. These conflicts are escalating today because, in my opinion, the United States is trying to increase protection of its domestic markets. At the same time the Asian nations are still pushing their exports to carry their own economies. A decline in the value of the dollar against the yen will help to an extent to lessen competition, but it does not offer a long-term solution.

Another trend in international trade is likely to be decreased trade between the less-developed and the developed countries, primarily in basic commodities and natural resources. Despite the fact that the less-developed countries need to earn export revenues to service debts, these particular markets are becoming saturated. It's happening already in oil, tin, rubber, and other areas. Prices are down; it's a very unstable situation.

The newly industrialized countries—Hong Kong, Taiwan, Singapore, and Korea—have had greater access to U.S. markets in the past. They still have great access to European markets, but they're going to have to restructure their own strategies to make up for the protectionism sentiment that will hit them in their basic commodities.

What does all this mean to U.S. industries? We are moving into an era of "managed trade." There will be more voluntary agreements concerning trading practices as opposed to unilateral protectionism. There will be many more bilateral agreements between countries, with respect to specific products and services. A bilateral free-trade-zone agreement was concluded last year with Israel. Similar arrangements are under discussion with Canada and with Mexico and other Latin American countries. Other bilateral talks are under way concerning trade in specific products and services. At the same time, the general system of international trading practices and preferences embodied in the General Agreement on Tariffs and Trade (GATT) is under review.

new international trade associations, and new international tr
agreements. At another level, countries are working bilaterally
get the best deals they can before new international regulatio
go into effect.

There are important developments in international finance
well. In less than 3 years, Japan has become the world's leadi
creditor, and the United States has become the world's leadi
debtor. It is likely that countries are going to continue to borrow
record rates. The United States will have to find new mechanis
to finance that debt. Deliberate development of countertrade
fers a partial alternative to increased debt. The implications o
countertrade strategy for marine terminals would be better b
ance between eastbound and westbound cargoes.

Another element of countertrade is being asked to take ba
products and services in lieu of credit or currency. Very few Am
icans know much about countertrade, yet the Japanese, Chine
and Europeans have been doing it for centuries. U.S. compan
will have to learn rapidly how to do business on a countertra
basis and to make a profit in doing so. Some of the huge mark
for U.S. firms in the years ahead, such as China, Mexico, Bra
Indonesia, and India, have very little cash to pay for what th
need, so they're going to insist on countertrade.

THE ROLE OF THE U.S. ECONOMY IN THE WORLD TRADING SYSTEM

With this understanding of trends in international trade
would like next to review the role of the U.S. economy in
world trading system. There's a trend in the United States to sl
down exports from the rest of the world. This has come about
a result of readjustments in primary industries and as a respo
to political protectionism. Those most likely to get hurt by t
are the high-volume, successful exporters in textiles, automobi
and other areas. The facts of life are that the U.S. market sim
cannot sustain the growth of these imported products.

The U.S. economy must respond to this with structural changes. New coproduction arrangements are already being pursued to give importers a domestic production base. This, in turn, will affect the character of trade passing through U.S. marine terminals. There will be more offshore sourcing to the U.S. market—through Canada or through joint ventures. The United States will remain the strongest market in the world for the foreseeable future, but the way the product is brought into the market from other parts of the world is changing. There is an unprecedented movement toward mergers in transportation as well as in manufacturing. Resulting economies of scale are already being realized in ocean freight transportation.

The diversification and merger of U.S. companies will more and more reflect a response to international and global strategy. We're going to see American companies become more global in their competitiveness. There will be more joint ventures and licensing agreements between U.S. companies and foreign companies. To an ever greater extent, U.S. companies will target specific international markets and go after them with full resources.

The years ahead in international trade will be an era of internationalization. No longer can an American company compete in a foreign market by just being an American factory and exporting its product. Position is becoming more and more important. Decisions about labor, sourcing, plant location, transportation, delivery, and distribution are being made on a global versus local basis. A recent example involves a sewing machine manufacturing business that spent a year looking at where a new plant should be. It wound up with a manufacturing facility in Taiwan, employing Chinese and other labor, shipping to Asia and other parts of the Pacific Basin, and finally reassembling in other countries and shipping to the United States. The resulting product is very competitive in the United States. So, truly, it is a globalization of industry.

INTERNATIONAL TRADE IN THE PACIFIC BASIN

The Pacific Basin is probably the most exciting story in international business in the twentieth century. Over the last 5 or 7 years, the economies of the newly industrialized countries of the Pacific Basin have grown 6 to 9 percent annually. California is an

in some cases less. This slower, though still vibrant and highly competitive, growth will force more selective investments. Japan is likely to continue its strong growth, albeit with greater international responsibility. Japan has finally realized that the status of economic superpower comes with international responsibilities for economic stability. Japanese overseas investment will increase as an expression of this. Another development is that the Japanese domestic market will be opened to a greater extent.

Hong Kong will continue to prosper as a regional center of trade. The big news for Hong Kong and for all of us dealing in that trade is the gateway to China. It appears that it's going to be business as usual for 50 years after 1997. More important for world trade, perhaps, is the influence of Hong Kong on the People's Republic of China. That's going to be a very exciting commercial window. European and American firms are going to increase their activities and investment in Hong Kong. Hong Kong will continue as a center of operations for East Asia and China.

Singapore has some current economic problems. High energy costs, demand for high technology, and overbuilding have all hit Singapore at once. Singapore will, in time, solve its current difficulties. Its economy will be diversified, so growth will resume.

Those Pacific Basin countries who will have a tough time adjusting in 1986 and 1987 are the heavy commodity exporters: Indonesia, Thailand, and Malaysia. Protectionism will hurt them first. They're going to respond by looking for strong, bilateral agreements between the United States and Europe.

To summarize, the Pacific Basin looks ahead at continued fast growth, but the pace of growth will slow, particularly in electronics, textiles, and basic manufacturing.

GOVERNMENT POLICY IMPACT ON WORLD TRADE

Changes in government policy affect international trade. U.S. trade policies are becoming more aggressive. We're going to see

nore efforts to support U.S. industries to be more competi-
it I don't know if that's going to increase trade very much.
o say I'm a free trader, but I finally realized there's no such
s free trade. Today I'm a fair trader. There's a tremendous
of protectionism in this country, which adversely affects in-
onal trade. Those of us involved in international trade need
nore to educate our national leaders on the importance of
de.

CORPORATE STRATEGIES

it strategies are American companies adopting to compete
world economy? Joint ventures are increasingly important.
nies are searching for imaginative ways to amass resources.
ies, from auto to steel, chemicals to computers, have gone
Many American firms now are joining with Japanese or
an firms to work in yet another region of the globe. We're
o see more of this important development.

re will also be a second wave of investment by Pacific Basin
ies in the U.S. economy. The large companies are already
Smaller companies with revenues of $100 million to $500
are following. These companies want to establish a mar-
base. They want to take advantage of the research and
logical capabilities available in the United States, as well as
ucational resources. Accompanying these developments is a
owards the globalization of financing.

erican executives have to cope with the internationalization
marketplace. This will involve:

lesigning products for the broadest possible international
acceptance;

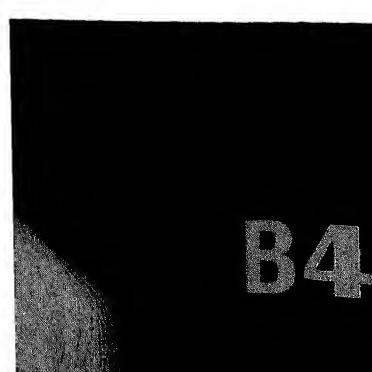
hoosing marketing and manufacturing strategies that
ie worldwide least cost with best access to resources and
logy;

hoosing financial strategies that spread risk across countries
clude the ability to raise capital on a global basis;

ising a worldwide work force that makes best use of com-
ve costs and technical expertise; and

leveloping global distribution systems and information net-

investment, cater to joint ventures, look at the effect of user fee and import surcharges on ports and international trade, and ask ourselves, "Is this good policy in the long run?" The answers will not come easily. We all must do our part.



ΓHE MARINE TERMINAL— AN ELEMENT OF RANSPORTATION SYSTEMS

Productivity from a Rail Transportation Perspective

DAVID BURNS

lant material exists on current technologies of intermodal , including marine terminals. I will focus upon what on Northern (BN) Railroad sees, from our own experi- at inhibits productivity at marine terminals which we will then comment on what we would try to do if we were ble for that operation.

ally, I would not attempt to do this. It is annoying to outsider tell me what is wrong with BN's intermodal s, and what he would do to improve them, especially has little knowledge concerning their practical capacities esponsibility to implement the proposed panaceas.

villing to offer such comments here for two reasons. First, l is dealing with marine terminal productivity not in an vacuum, but as an element of a transportation system.

Burns is director of the Intermodal Department, Burlington North- ad.

At BN we are learning to listen attentively when customers speak. How else will we know what they need to compete and grow, and what we can do to increase our value to them? Likewise, I hope my comments will be helpful to the workshops on improving the productivity of marine terminals, and in improving their product and value to their customers.

IMPROVING SYSTEM PRODUCTIVITY

1. *What marine terminals might do to improve system productivity at their end.*

a. Have special gate lanes for special, volume moves.

Presently, except for longshoremen-drayed interpier moves, all shipments go through the gate line on a first-come, first-serve basis. BN routinely sets up special lanes for high volumes. Unit type moves, such as a large number of import loads of a certain ship or from a certain customer for a certain train, reduce gate time for these repetitive, prearranged units, as well as free up space and time at the regular gate. For example, when a railroad has an inbound train of empty containers on even export loads to ground and bring to a pier, run them through a special lane rather than through the regular lanes.

b. Make pier hours of operation more flexible and responsive to user needs.

Rather than having all pier employees take breaks and lunches simultaneously, stagger the times so that the particular pier is performing work during the entire shift. Draymen and users otherwise get caught during the dead time. Some piers are now down 20 percent of the time.

Furthermore, stagger starting times so that piers work more closely with the 12-hour-day pattern in effect by users—nominally 6 a.m. to 6 p.m.—rather than the traditional 8 a.m. to 5 p.m. work day on piers.

Base work schedules on volume requirements, rather than set similar hours each and every day. Presently users fight to get in during the 8 a.m. to 5 p.m. window in order to avoid extra charges to set up extra shifts. Many shipments would more logically and smoothly flow on a second or third shift. But even when an extra shift is arranged at extra cost, the flow is further impeded by a 1-hour shutdown between the day and afternoon shift, and a third shift that only works 5 hours between 3 a.m. and 8 a.m. This impedes orderly and fluid asset utilization.

c. *Obtain ocean bill of lading information from shippers rather than draymen.*

Presently, gate delay results from draymen submitting ocean bill of lading information (vessel, voyage, or destination data) to the pier operator. In the case of BN, we have to call the shipper to obtain this and in turn furnish it to the pier via the draymen. The shipper has previously contacted the pier to book space. Why not have the shipper provide all necessary movement and billing information at that time, either via phone or facsimile electronic mail? This would cut out the middleman, plus save time and paper both at the rail and pier gate facilities.

d. *Change Customs procedure of bond verification.*

Customs needs to verify units moving in bond. But at present, an additional seal is placed on shipments moving individually in bond, or under a master to cover shipments of less than six units. These require time to apply and then subsequently record and verify as the shipment moves through the pipeline. Is the second seal necessary in addition to the current verification procedures?

e. *Eliminate gate requirements that cause drivers to have to leave their tractor.*

At many piers, drivers must leave their tractors to complete paperwork. BN is working to simplify or eliminate such paperwork, including the use of talk-back speakers, so that drivers do not have to get out. This reduces total gate time considerably, plus streamlining the overall paperflow.

f. *Organize, stripe, label, and number the parking areas more clearly to expedite pickup/drop off.*

increasing use of computer assists
facility operation as contrasted to manual methods.

g. Establish a local coordinating association at each identify and resolve problems.

Most railroads have an agents Association or an op ficers association in each major terminal area. Meeting monthly to identify and resolve operating problems, hances the productivity of the product for the custo haps this concept should be applied to the compone marine terminal network—namely the steamship lines, ators, major drayage firms, and railroads. Each would a knowledgeable representative empowered to try new w solving productivity impediments. The group would es agenda and prepare progress reports to otherwise avoid just a debating society. In other words, the group would *try*, rather than just *talk*. The group might see the ben outside review of paperwork and paperflow systems in ar identify and implement a more common system. Right component of the system pretty well goes it alone, and ot to adapt as best they can. This often produces additiona creates errors and delays.

Such an operating officers association might further for standardizing handling equipment. Presently each co group is pretty well going it alone. There are surely are greater knowledge of the entire system's individual nee produce more versatile and universal useable equipment ample, straddle cranes wide enough to go over a flat car a a box, or pier cranes that can bottom as well as top pick.

2. *What the rail partners are trying to do to improve syst ductivity.*

a. Improve throughput time for draymen.

Time is money, whether the railroad, the marine terminal, or the customer provides the drayage between the pier and the railcar facility. One way to speed this up includes advance scheduling of deliveries, so that on arrival the driver is sent to a trackside car spot where a crane is waiting to put the unit directly onto the rail car.

Another way is to have the railroad waive inspection of units arriving at the gate, and instead accept and use the marine terminal departure record as contrasted to a duplicate inspection process.

A third way is virtual computerization of the gate arrival process at the rail facility. Rather than spend time manually writing down information from the drayman regarding the shipment, have as much as possible predelivered and already entered. Enter the rest direct as the driver gives it while the rail facility employee is hearing it and looking right at the unit. This saves time and prevents errors.

A fourth way is to eventually have all movement and billing information transmitted electronically from the customer to the carrier. This is being worked on in a number of areas, including the Port of Seattle, and is a logical next step in data processing productivity to benefit transportation system participants and our customers.

At our Seattle International Gateway, we had hoped to get draymen out within 30 minutes after they had entered. We are presently averaging 10 minutes, in large part due to these steps.

b. Improve load ratios for draymen.

Even though BN does not provide drayage to and from its Seattle International Gateway, the railroad feels obliged to minimize one-way or bob-tail moves as much as possible. As a result, we organize the daily operation to provide a return unit for the draymen to take back to the pier, if at all possible.

3. *Some ideas that might work for you, for us, and for our customers.*

a. Implement neutral chassis pools.

While this concept is not new, it appears to have wide areas left for implementation.

facility, either from one chassis to another, or from a stock
another. Instead, units go from rail car onto a chassis and o
gate. Should the outbound drayman not be there, the un
parked short term in a holding lot at the rail terminal, or
term at an off-site surge lot operated by the pool contrac
the customer. But the units are handled only once. In ad
chassis ownership, operation, and maintenance cost less th
individual participants were able to obtain.

b. Implement a neutral surge facility.

Neither marine nor rail terminals appear to be logical
to congest with units that cannot move that day. Space a
facilities is costly. Efficiency is improved with steady flow lo
not start and stop. Terminals work hard to develop capacit
contingency plans to survive these situations.

Wouldn't it be better to use the transportation system a
utilize a neutral surge lot, in between the pier or the rail te
and to hold surplus supply until it can be fed into either en
a blocking diode, the neutral surge lot would come into pl
when either end became congested. It would preclude com
overload.

Our Chicago neutral chassis pool provides this feature fo
term surges, and we are pushing the system to respond t
term surges as well. The middle ground has more capaci
either marine or rail facilities to store units that canno
immediately.

*c. Get rail cars out onto the piers and eliminate dra
between.*

This idea is not new and is fraught with feasibility
plementation difficulties. It would require a large surge a
facility in between trackside and shipside. It would not app
locations and situations, but it certainly appears to have
for some, including:

- elimination of the entire drayage component and expense;
- ability to make last minute changes in load patterns to reflect iarket or customer requirements; and
- reduction of overall terminal space requirements by using igh-density stacking and sorting technologies within the surge-ort facility that are not feasible at an individual terminal.

Marine Terminal Productivity as it Relates to the Trucking Industry

ROBERT A. CURRY

The majority of cargo, with the exception of steel, automobiles, aper, and lumber, that is handled today is containerized in some ashion, so this report involving issues of productivity at marine erminals as related to the trucking industry is directed primarily oward container facilities.

The basic purpose of a modern marine terminal is to berth a essel, to load and discharge from 500 to 3,000 containers, and to ail the vessel in the shortest period of time. Because of the impor-ance of maintaining schedules and of the high daily cost, the main ommitment of the terminal activity is to turn the vessel around in he shortest period of time. This leaves the other required services f the terminal, such as delivering and receiving containers from ruckers, in a secondary role. Containerization and the secondary ole that has been left for truckers has created dramatic changes in hat part of the trucking industry that interfaces with steamship ines and marine terminals.

It was not that long ago that the owner-operator was the ex-eption, not the rule, in the movement of cargoes to and from he steamship berths. Ten years ago, it was hard to find many ndependent owner-operators in the various harbors. At that time here were many large carriers (mostly unionized) who owned, op-erated, and maintained their own equipment. They handled the ulk of the containers that were moved between the steamship erths and the shippers, consignees, or rail yards. These carriers

Robert A. Curry is president of California Cartage Co.

erating fleets of owner-operators. Some of these ow make a sincere attempt to maintain their tractors safe standards and to carry reasonable limits of ins ever, there are a large number of these owner-opera working today without proper authority, without in with questionable road-worthy equipment. Many o operators in the Southern California area today are speaking, and some may even be undocumented work

As the large carriers disappeared from the harbor the quality owner-operators disappearing. The owner paid either a flat rate or a percentage of revenue for ea that he transports, so his ability to make a reason is dependent to a great deal upon how fast he can t at a given marine terminal and on how many contai either pick up or deliver each day. Many of the pr policies employed by marine terminals directly affect tivity of the trucking industry serving these terminal in some of these practices and policies could significant the productivity as it relates to the trucking of these c

Regarding the two types of container terminal oper wheeled operation is far superior in productivity for t than is the stack operation. Anytime a trucker, who multiple moves of containers, can drop an empty on and immediately pick up a load, the productivity of the will be much greater than if the same trucker had to g transtainer to have the empty removed and then repe eration to pick up a load. The productivity of a truck containers from a wheel-configuration marine terminal is 50 to 100 percent greater than if he were moving the s tainers from a stacked operation using transtainers. The industry has generally found public terminals to be sub more restrictive than steamship-owned terminals; cons the productivity at these terminals is less. It would app there are issues pertinent to productivity that involve bo

of operations; however, from the trucking point of view more impediments seem to exist at the grounded container terminal.

GROUNDED CONTAINER OPERATIONS

The processing by the trucker of the paperwork required by the terminal company is similar for both the wheeled operation terminal and the terminal whose containers are grounded. However, the physical aspects of picking up and delivering the containers are very different. In a terminal operating a grounded operation, the trucker is responsible for going to a separate area of the terminal and securing a road-worthy chassis. If he cannot find a chassis free of defects, he has two choices. He can take the chassis to the garage area of the terminal and wait while the defect in the chassis is repaired, or he can just take the chassis. Many times the driver just takes the chassis so he can get his container and be on his way. Once he has the bare chassis, he moves to the aisle where the container he wants is stored. There may be from 1 to 10 trucks in front of him waiting for the transtainer to service them. In some cases, the transtainer operator must dig through the stack of containers to secure the desired one. Depending upon the volume of traffic at the terminal, the elapsed time to pick up the chassis and secure the container can vary from 45 minutes to 4 hours.

When that same trucker returns with the empty container, he must have the completed unit inspected by a mechanic. These mechanics are looking for every type of exception from cut tires to missing twist locks. These exceptions are noted on the interchanges that the longshore union clerk prepares, and, wherever possible, the exceptions are costed and charged to the trucker. There are always less exceptions taken on returned equipment at marine terminals who have wheeled operations versus those with grounded operations. Most marine terminals using a grounded operation are easy going out and tough coming in.

The trucker then gets in the empty receiving line. Some terminals only apply one piece of yard-handling equipment to handle the decking of empties. In some cases, the drivers must wait in the empty line until the lift or transtainer operator changes the spreaders from 20 feet to 40 feet, or vice versa. If the terminal had one top handler for the decking and setting up of 20-foot

and chassis, thus speeding up the operation.

After delivering the empty, the trucker takes the chassis and repeats the procedure described earlier for picking up a full container. Because you have two separate operations inside the terminal—delivering the empty and picking up a load—the time elapsed for the trucker can vary from 1.5 hours to 6 hours.

The largest block movement of containers for any terminal is the landbridge schedule. Because of the advent of stack trains, this movement becomes extremely time sensitive. Sometimes the entire vessel's landbridge discharge must be moved from the marine terminal to the railroad within a period of less than 8 hours. Consequently, a discharge from the vessel direct to the road chassis is nearly imperative. However, if limitations or shortages of chassis prevents this, then a system should be developed that places these containers in one area so they are segregated from the local boxes. Then transtainers can deliver them to the trucker without digging into stacks. Because the railroads operate on a 24-hour basis, ordinary landbridge movement lends itself to a night or weekend operation, and moving these containers during other than normal working hours tends to minimize congestion during the day.

GATE OPERATIONS

The productivity of a gate operation, as it relates to the trucking company, varies greatly from marine terminal to marine terminal. A major complaint of the trucker at many terminals is that he has waited for an inordinate amount of time outside the terminal in line. This situation seems to be at its worst in the morning, prior to the start of business, and just after the completion of the lunch hour when work again is starting up at the marine terminal. Possibly a system with staggered lunch hours, thus keeping the terminal open during the noon hour, would alleviate the situation in the afternoon, especially at heavy volume terminals with back-to-back schedules of vessel receiving and discharge.

steamship line's container freight station (CFS) in order to secure the release of the shipment and the proper paperwork which will allow him to pick up the loaded container at their container yard (CY). In this particular case, the CFS is not located within the confines of the CY area, so the trucker is forced to make a stop at a separate location before he can obtain the necessary paperwork to pick up his container. At other marine terminals, truckers are sometimes forced to go to more than one building to secure the paperwork and, in the process of doing this, they must stand in separate lines to consummate each transaction. Each of these situations consumes valuable time, reduces the trucker's ability to make the maximum number of turnarounds each day, and causes congestion inside the terminal with tractors parked wherever they can to satisfy the terminal's procedure.

The trucker's productivity would be greatly increased if he had to only stand in one line and see one person to consummate all transactions. No matter whether the trucker was picking up a full, delivering an empty, or both, the operation would be substantially more productive if what was necessary to consummate the operation were handled by one person at one place.

AVAILABLE PRODUCTIVE WORKING HOURS AT A MARINE TERMINAL

When analyzing the marine terminal's working hours, which are between 8 a.m. and 5 p.m., it is apparent that there is probably less than 7 hours of productive working hours when you discount start-up time, coffee breaks, and the lunch hour. The railroads, the motor carriers, and the airlines have all adopted flexible starting times and flexible work needs for the purpose of increasing overall productivity. However, the steamship industry still maintains very rigid working hours. Congestion and delay time for the truckers would be greatly reduced if service hours were increased. Productivity would also be enhanced if flexible work hours were developed so that clerks and marine terminals could continue to operate during breaks and lunch periods.

...als to handle peak hours. Any or all of these work-ru... would markedly increase productivity at the marine ... For example, if, through staggered starting times, mar... nals could open at 6 a.m. and close their facilities at 6 p... much of the bunching and congestion of trucks at these... would be eliminated.

Contrary to the rail industry, which has developed st... that ultimately improve the overall productivity of m... cargo inland, the trucker must still use one tractor to ... 40-foot container between the marine terminal and its ... destination. We have no new innovations that are going ... more containers over the highways faster. The ability of th... to do this is predominantly determined by the efficiency ... working hours of the marine terminal. The real producti... trucker at a marine terminal is measured by the number of... it takes him to either pick up or deliver a container from ... he arrives in line at the marine terminal until the time he...

The trucking industry is in a transition period. The... of the owner-operators continues to deteriorate because ... unable to generate adequate revenue for the services th... perform. Much of these problems are caused by delays a... gestion at the marine terminals. Increased productivity... marine terminal would greatly enhance the trucking in... ability to move more containers in a shorter period of tim...

In its 1984 annual report, the Marine Board of the National Research Council noted that "there are indications that shippers nd ports in the United States may be losing import and export pportunities because of conditions in U.S. ports, including marine erminal productivity." Furthermore, "for cargo handling systems n which the United States is pre-eminent, productivity of use in his country is below that of other countries."

While most steamship lines, stevedoring companies, and termi-ıal operators guard their respective productivity figures as closely s a sales department would guard its customer list, it is generally ccepted that, given equivalent container-handling equipment and acilities, European and Asian stevedores and terminal operators lo outproduce their U.S. counterparts. Compared to the theoret-cal design production capability of most shoreside cranes, U.S. productivity is usually in the 45 to 50 percent range.

$$\frac{\text{20 lifts/hour (U.S. average)}}{\text{40-45 lifts/hour (design capability)}} = \text{45 to 50\%}$$

Compared to typical crane productivity figures in Asia and Europe, U.S. crane productivity is generally only 57 to 67 percent ıs good.

$$\frac{\text{20 lifts/hour (U.S. average)}}{\text{30-35 lifts/hour (Asia/Europe average)}} = \text{57 to 67\%}$$

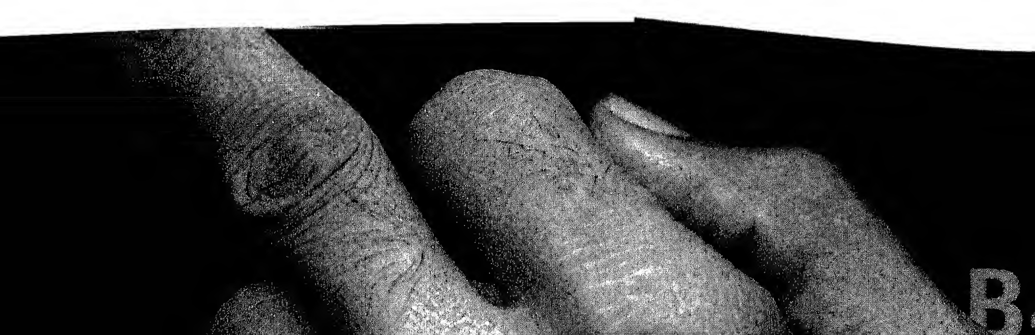
Productivity in a marine container terminal generally breaks lown into three principle areas of concern: (1) stevedoring, (2) container yard, and (3) receiving and delivery gate. (For purposes of this analysis, it is assumed that container freight station oper-ations are not an integral part of the marine container terminal.)

L. P. Robinson is senior vice-president of operations, American President Lines, Ltd.

...ed cost per acre or on a wharfage ... commitments based on a minimum container throughput volume. The stevedor... pany often has fixed guarantees for a portion of its w... in order to ensure continuity in certain aspects of term... stevedoring activities. The trend in contractual arrangem... tween the stevedoring company and the steamship line ... toward a fixed throughput rate per container lift. Given ... capital investment and fixed-cost base, the stevedoring c... must attain a high productivity to make a profit. The... the fixed-cost base as a percentage of the total cost, th... stevedoring productivity will affect profitability.

The vessel operator typically has a huge capital invest... his ship and support equipment such as chassis and con... His interests center on getting the ship in and out of ... quickly as possible. Simply stated, "A ship doesn't make ... while it's tied up at the pier." The vessel operator can ... from increased stevedoring productivity in many ways:

- By sailing ahead of schedule the vessel can proceed ... next port at a slower speed to make its scheduled arrival, ... can dramatically reduce fuel consumption.
- If the vessel is behind schedule, decreased time in po... help to get it back on schedule.
- Frequently crew overtime payment for off-hour sailin... be eliminated.
- If the productivity at each port on the vessel's itin... was consistently and dependably high, the deployment invo... numerous vessels in a scheduled service, could be chang... provide for additional revenue generating port calls or increm... round-trip voyages, with the same vessel assets, over a fixed p... of time, (i.e., improved asset use). That same consistency ... dependability, when applied to a number of vessels in the s... deployment, could even result in the reduction of one ship in... deployment, while still maintaining the same service levels.



Frequently, the design, control, and physical operation of the container yard (CY) has a direct bearing on the costs and productivity of the vessel stevedoring operation. If containers for outbound loading cannot be readily located at the time they are needed for loading, stevedoring productivity will suffer. Likewise, if the physical layout of the CY is subject to traffic jams that impede the flow of containers to and from the ship in any way, productivity will be negatively affected. Finally, if proper supervision of CY activities is not provided, even a superbly designed CY will not function properly, and again the stevedoring productivity will go down.

One must bear in mind that in most CY operations, there are numerous activities, besides the stevedoring operation, taking place simultaneously. Local truckers are bringing in loaded containers for export and returning empty containers. Other truckers are picking up imported containers for delivery to the consignee, and empty containers for export loading for future vessels. Containers are flowing to and from the container freight station for vanning and devanning. Containers are being moved to and from garages for servicing, maintenance, and repair. Containers are being examined and inspected by Customs authorities, Food and Drug Administration representatives, and other authorities. Impediments to a smooth flow in any one of these individual activities will frequently have a snowball effect on the efficiency of all the other activities, including stevedoring productivity.

Before the export container gets parked in the CY to be ready for loading to the vessel and after the import container is discharged from the vessel and staged in the yard, it must pass through the receiving and delivery gates. Here again, delays at the gate result in problems in the CY, which result in stevedoring delays. Many of the loaded and empty containers that get caught in a jam-up in the receiving lanes may be destined for the waiting crane that is working the ship lying at the berth.

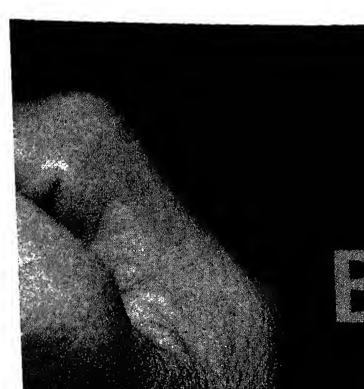
WHO CARES?

As previously discussed, the vessel operator cares about productivity. Even if he enjoys a fixed-cost, per-unit stevedoring rate, which, theoretically, is not altered by poor productivity (at least until his next contract negotiation with the stevedoring company),

Certainly the stevedoring company/terminal operator s care, since his profitability, and possibly even his economi vival, are dependent on productivity. The days of cost-plu tracts, and the practice of passing on inefficiencies resulting poor productivity, are rapidly disappearing. Flat-rate p pricing forces concern for productivity. The stevedoring cor has to make money on his existing clients in order to retain and to stay in business; to make a profit he has to be produ In order to increase his business, his rates and productivity to be attractive and competitive, and the service he provi the vessel owner has to be dependable.

The trucker, a key link in the chain, should also care. Wl the truck is operated by an owner/operator or an emplo a trucking company, its profitability is determined by how containers, or how much cargo, it can handle in a finite a of time. As it relates to the marine terminal, the primary of potential delay are waiting at the receiving and delivery searching for containers in the CY, waiting for chassis or cc ers to be provided, paperwork problems, Customs detain and roadability problems with the chassis, container, or r equipment.

The longshore worker should care. The American worke cally gets paid more money and enjoys a higher standard of than his counterparts in foreign countries, yet typically pr less in today's environment. For decades, America stayed on the productivity curve, primarily due to technological opments, innovation, and ingenuity. Today, there are few foreign ports without container-handling equipment tha least comparable to the equipment in U.S. ports. Based assumption that some, but not enough, U.S. workers do ca analysis of stevedoring productivity must include an exami of the work ethic and motivational mind set of the An longshore worker.



The port authority, regardless of whether it actually operates the port or acts simply as a landlord, should have concern for productivity in all areas of the port's operation. Poor productivity will cause the port authority to make huge capital investments for additional facilities in order to compensate for inefficient use of existing facilities. Such investments may be premature at best or totally unnecessary at worst.

Last, but not least, the customer should care. The proprietary owner of the goods, whether an importer or an exporter, is the one who pays the bills for all the other parties. Poor productivity ultimately costs him more money for the transportation services that are provided. Additionally, if he can't get his cargo to the pier to make the appropriate vessel or if he can't get his cargo off the pier without undue delay, he may suffer additional internal costs, dissatisfied customers of his own, and eventual cancellation of orders and loss of business.

There are many parties involved, and they all should care. Each party's long-term potential for profit, or wages, as the case may be, is inexorably linked to the performance of the other parties. Productivity involves the efficient use of time, and time is money. If all this is true, then why is stevedoring productivity in the United States so poor, and what can be done about it?

HOW TO IMPROVE STEVEDORING PRODUCTIVITY

The Ship

Many physical elements in the design of the ship can have a positive impact on productivity. These include the following:

- automatic trim control to minimize listing during cargo operations;
- gathering guides at the entrance to the cells, large enough to facilitate entry of the containers to be loaded;
- proper placement of the house, on-board cranes, and other structures to minimize the necessity to "boom-up" when shifting from hatch to hatch;
- gathering guides painted with high-visibility paint for day and night operations (this can improve crane operator performance);

Shoreside gantry cranes can be initially built or modified to enable greater productivity.

- The comfort of the operator should be considered. A comfortable seat, optimally placed to maximize visibility, and simple, well-placed, user-friendly controls are a must.
- Line speeds for hoisting and trolleying should be maximized, within the limits of safety.
- Expandable spreaders and quick change headblocks to enable efficient changing of spreaders for handling differing container lengths are necessary.
- The design of flipper guides on spreaders is critical for efficient handling of above-deck containers, as well as mating the spreader to containers ashore.
- Sufficient, appropriately placed lighting is necessary for productive night operations.
- Antisway devices may be useful for less-experienced operators, but may actually hinder the productivity of highly skilled operators.
- Selection of crane gauge (i.e., 50 feet, 80 feet, or 100 feet between crane legs) may or may not be a factor in productivity depending on the number of cranes in simultaneous operation on one ship and whether or not a parallel lane versus single lane methodology is employed in taking containers to and from the spreader.
- Good preventative maintenance practices on cranes should be followed to minimize crane downtime during stevedoring operations. Downtime in excess of 1 percent (during stevedoring hours) is unacceptable to the productivity minded stevedoring company.

Other Container-Handling Equipment

While the focus of the stevedoring operation from a hardware perspective centers on the ship-crane relationship, there are many other container-handling devices involved that need to be considered from design, operation, reliability, and preventive maintenance standpoints. A grounded operation employing straddle carriers, transtainers, port-packers, or any combination demands attention to many of the same concerns discussed for cranes. Operator comfort, visibility, user-friendly controls, line speeds, spreaders, spreader flippers, and lighting must all be taken into consideration. Slope-sided, oversized "bath tub" chassis are desirable for use in a grounded operation. This type of yard chassis speeds up the process for the crane or other lifting device to place the container on the chassis. The need to position the container precisely on four small twist locks, by an operator who is 40-90 feet in the air, is eliminated. This latter process is a significant drawback to the fully wheeled (staged on street chassis) operator, for as much as 50 percent of his stevedoring lifts.

In either a grounded or fully wheeled operation, a common thread is the stevedoring tractor. Productivity-minded stevedoring companies will benefit by careful selection of the appropriate unit, considering size, wheel base, ease of steering, operator comfort, hydraulic fifth wheel, and convenient air-line connections. Some stevedoring companies in transtainer operations are currently using high-horsepower tractors that enable one unit to pull as many as five chassis-mounted containers, the obvious benefits being a reduction in the number of trips between stack and ship, fewer tractors to be purchased and maintained, and fewer tractor drivers required.

The Terminal

The design of the container yard is a critical element to productivity.

- The fendering systems should be designed to absorb the shock of ship movement, to enable the ship to be aligned parallel to the crane rails, and to be kept tightly alongside by constant tension winches that minimize movement of the vessel.

should be installed to facilitate traffic flow and to eliminate confusion for tractor drivers.

- Receiving and delivery lanes should be designed for flexibility so that returning empty containers, bare chassis, and bob-tails are not stuck behind a long line of incoming loaded containers in scale lanes. To some degree, incoming and outgoing lanes should be interchangeable so that heavy traffic flows, in one or the other direction, can be accommodated. Changeable lane directional signs and markings are required in order to divert the normal flow of traffic to and through the lanes.
- Adequate lighting should be provided.
- Proper paving and drainage are essential to maintaining productivity, especially during inclement weather.
- Overall traffic patterns between yard and ship and between street and yard should be designed and well marked to mitigate peak period congestion problems, when various operations are being conducted simultaneously.
- A well-designed and properly used computer-assisted yard control program, to keep track of chassis and container locations and vacant slots, will greatly assist both CY activities and stevedoring operations. The need to search for containers will be dramatically reduced, and traffic flows will be improved, if a row or stack location is always available for each container and each container is in its proper place.

The Human Element

We have addressed what it takes to get a properly designed ship berthed at a properly designed terminal, supplied with properly designed and well-maintained container-handling equipment. These elements are already in place at most U.S. port facilities. *So why can't they get better stevedoring productivity*?

The reader will, no doubt, note that the preceding synopsis

barely dealt with new (existing or future) technology. This was intentional. This industry should be actively engaged in finding ways to improve the use and productivity of existing assets, as a priority to spending huge amounts of capital to develop new technology for productivity improvement. One is not exclusive of the other, but the priority should be geared towards getting more out of what currently exists.

There are literally dozens of studies going on with regard to improving stevedoring productivity. The industry is looking at relatively simple time and motion/industrial engineering type studies, which measure everything from the arc employed in load and discharge cycles, to the time required in every component and activity involved with stevedoring, calculated into hundredths of a minute. The primary finding of these studies is that U.S. terminals are not using their assets anywhere close to their designed capabilities. The prevalent reasons are poor planning, poor management and supervision, and poor labor.

From there the research departs to high technology items, including:

- two-trolley cranes;
- chassis positioners;
- electronic and laser guides between crane and vessel hatch;
- acoustical wave and electronic impulse readers for tagged containers and chassis;
- fully automated cranes; and
- fully automated terminals.

Some or all of these technological innovations may come to pass in the not-too-distant future. Few, if any, of these innovations will obviate the need for the industry to concentrate a large part of its efforts to improving the most important factor affecting productivity of existing assets—people. In its simplest form (where productivity is concerned), the human element breaks down into two basic components: *management*, which decides what needs to be done, when it needs to be done, and how it's to be done, and *labor*, which performs the work to be done, in accordance with the plan devised by management. This ranges from clerical input into computers or manual forms, to driving tractors and operating cranes.

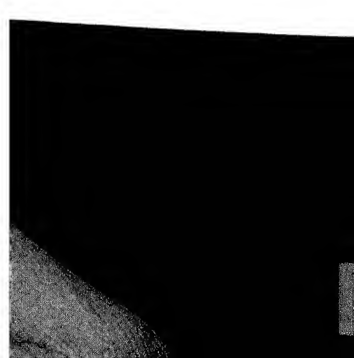
do the job in the most cost-effective and efficient mann
interval planning is not properly accomplished, and re
the need to make changes is slow.

Control and Management

Even the best plans are subject to a myriad of changes
paced stevedoring operation. Therefore, management m
control of the situation and must promptly react to ch
order to facilitate the operation's progress, so that produ
not adversely affected. Another facet of control that is fr
absent in stevedoring operations is good, old-fashioned d
When the crane is not being fed with containers bec
tractor drivers are delayed in the yard somewhere (wh
not it's intentional), you'll frequently find the supervisio
office or attending to other duties. The primary dut
supervisor is to supervise—not to be performing pape
other tasks that are unrelated to ensuring a smooth, pr
physical operation.

An adequate number of concerned, well-trained, and m
supervisors are essential to good production. Are your sup
competent? Consider the following questions:

- Do your supervisors know that management *does* ca
productivity? Do the supervisors themselves care?
- Do they plan their operation so that a foundation
trolled change exists?
- Does the planning process enable them to anticipa
problems?
- Do they have enough "street smarts" to foresee p
and to make proactive changes before the problems occur
- Are they afraid or coerced by labor, or by the union
- Are they adequately compensated for what you ex
them, and relative to the people they supervise?



• Do they know "the book" (labor contract), local work rules, and results of prior arbitrations so they know what can and cannot be done?

• Do you give them enough slack so that they know it's all right to make a mistake once in a while, but that they should learn from mistakes and not repeat them?

• Do they communicate and coordinate with other components of the operation, e.g., CY, CFS, gate control, yard control, maintenance and repair, or the documentation department?

• Do they understand that you expect them to *manage* the situation, not simply to act as a trouble shooter, coordinator, and technical adviser?

If you don't have the answers to these questions, you'd better get them because things aren't going to change until the supervisors are properly motivated to effect change. The bottom line is this: If *you* don't care, why should they?

Labor

We have identified the importance of the good ship, in the good terminal, serviced by good container-handling equipment, and managed by good supervisors, but we're still not getting good productivity. There's one more factor in this equation—*labor*!

The person doing the physical work is an adult human being. Human beings are subject to human nature. Human nature drives a human being to take the easiest course unless he's motivated otherwise.

In any group of people there tends to be a common mix of good, poor, and in-between types. This is true of a parent and teacher association, a football team, a management group, or a labor force. Generally speaking, 10 percent excel and do their best at everything they attempt. Another 10 percent are lethargic, lazy, and incorrigible, and do as little as they possibly can to contribute. Neither extreme of this spectrum is easily changed. What makes or breaks the P.T.A., the football team, the management group, or the labor gang is the 80 percent that's in the middle. If this group is permitted to drift, human nature will take over, and it will tend to drift towards complacency in its performance. The good news is that the "80-percenters" can be affected, and they'll lean towards the high-performance side if they are properly motivated.

has been done and suspects that chaos will be the order
day, there will be little productivity. Conversely, if the op
appears to be well planned and organized, a momentum t
build, the momentum becomes infectious, and good prod
typically results. Once the momentum is there, it has to
up. Container availability for outbound loading must be a
and the crane must be continuously fed. Few things will
momentum and cause the tempo to plummet faster than a
up and wait" type of operation. Simply stated, all the p
impediments to productivity must be eliminated as a first
keeping the labor properly motivated toward high perform

The onsite management must be firm, but fair and co
in its dealings with the work force. The basic plan and
sary changes to the plan must be communicated to the
Participatory management (not management abdication)
be encouraged, so that the workers feel as if they are a
the operation, and feel a sense of obligation for its prop
timely completion. Management must dispel the feeling t
worker is only a tool. Each worker must be respected and
like a human being. When he doesn't perform and fails
warnings, the fair and consistent application of discipline
present.

The primary key to productivity is an inspired, motivate
trained work force. However, it's difficult to reach peo
don't work for you consistently. What most terminal o
and stevedoring companies need is a steady work force, a
of people who work for the same company every day a
are capable and willing to perform a multiplicity of task
basic work force must be supplemented by skilled people f
hiring halls for peak periods.

Given a steady, multipurpose complement of labor, the terminal perating company or stevedoring company could:

- Effectively train the people as to what needs to be done and ow best to do it.
- Educate the workers as to the yard layout, traffic flow pat-erns, and the general methodology employed at that particular acility.
- Switch workers from one type of work to another, as the orkload demands change from day to day.
- Introduce a productivity related, incentive pay system that ewards workers as higher plateaus of productivity are achieved.
- Give the labor force a sense of pride, self-satisfaction, and elonging that usually doesn't exist today.
- Pay each worker at the highest rate for which he is qualified, egardless of the type of work performed on a given day.
- Pay the steady workers directly, on a company check, instead f through an employer association.

Clearly, we don't have these things today. We also have little apport with our workers today, and it's not at all surprising onsidering the system under which they are employed. We don't ave the flexibility and dedication we need, but we should strive to et these things in the next round of contract negotiations. U.S. ompanies cannot continue to afford to subsidize underproductive abor at the high wage and fringe costs that currently exist.

CONCLUSION

Continued research into automation and other technological dvances, in terminal operations and stevedoring, is desirable nd essential. It should not, however, take place at the expense f ignoring the human factor in productivity. When we arrive t fully automated cranes, on fully automated terminals, the eople will become relatively unimportant. Most indications are hat such a date is far away. Until then, the prudent terminal perator and stevedoring company would be well advised to focus ts primary attention toward improving the performance of front-ine supervisors, as well as increasing the efficiency of the people who physically perform the work.

Productivity Concerns in Intermodal Terminal Operations

JOHN GRAY

Rail intermodal in the last decade has been the prime, long-distance-service, land transportation alternative for container-shipping lines and their customers because of lower line haul transportation costs than over-the-road transportation, ease of interchangeability of container equipment, and an inherent ability to accommodate ship-size lots of containers, whereas a motor carrier has a problem taking 500 boxes at a crack.

The capability of the railroads to move large amounts of cargo on relatively short notice creates unique problems within both the intermodal rail terminal and the marine terminal because everything tends to move in large chunks at a time. The result has been to force changes in terminal design and operating practices, including more flexible terminal design, changes in container-handling equipment, changes in operating procedures, and more flexible and creative labor practices.

To date, five so-called intermodal container transfer facilities, which are on-dock (or near-dock) container-loading facilities for rail cars, have been constructed or are in planning in the United States. The Port of Tacoma has two facilities, one on-dock (North Yard), one off-dock (South Intermodal Terminal). Burlington Northern's Seattle International Gateway is an off-dock facility. The Port of San Francisco's Intermodal Container Transfer Facility is an on-dock operation, and the Port of Los Angeles/Long Beach Intermodal Container Transfer Facility (ICTF), an off-dock facility, is the largest of all by far.

John Gray is president of Intermodal Management Services (IMS), a terminal-operating company. Several IMS terminals serve the ocean freight industry.

All of these facilities have certain common characteristics. They attempt to minimize drayage by locating the rail intermodal facility as close as possible to the marine facilities. They are designed to minimize the amount of chassis and containers stored at the facility. And they all employ improved freight documentation procedures, which is the key to making the facilities viable.

An innovation in our Seattle and Tacoma facilities that will probably be a model for the planned new facilities in California includes common use (between marine terminals and intermodal rail terminals) of the trailer interchange report (TIR). It's silly to have a marine terminal complete a detailed TIR and then get over to the railroad and inspect the whole thing all over again after a 3-mile trip on the highway. So, at Seattle and at Tacoma, we depend upon the marine terminal-furnished TIR. We think they can do just as good a job as we can. All we do is a quick cursory visual inspection to see if there's any obvious wreck damage.

We have worked with the railroads and the container-shipping lines to affect computer-to-computer transfers of freight forwarding and billing data. When a truck shows up at the Seattle intermodal terminal we already know it's coming; we have essential data in the system; and we can move the container through without any paperwork. Investing the terminal operator with control of documentation aids the centralization and automation of this function.

Advance notice of empty and loaded containers prior to the arrival of a train at the intermodal terminal is very helpful. We have formalized this to provide 24-hour advance notification of the arrival of specific containers at the terminal. Our service is reliable enough to back that up. This enables the terminal operator to meet the freight with adequate resources as soon as it arrives.

One of the key elements in operating rail intermodal facilities is no different than the trucking side or the marine side of the business. That is the necessity of labor agreements that are in tune with the most productive operations. Our facilities at Seattle and Tacoma and elsewhere have a number of characteristics in their labor agreements that provide a great deal of flexibility to innovate as needed. For one, they provide for a single job classification—everybody gets the same pay. That eliminates all the squabbles.

provides labor with the incentive to get in there and get ... done when it's needed, and it provides management with a sta... core of skilled workers.

We have no work rules. I think work rules are an inhib... to any type of productivity at all. We have common sense, ... we have an expedited grievance procedure that deals with ... injustice that would be created by a system that does not h... work rules.

Labor productivity is emphasized in our terminals. Everyb... in the terminal knows what the lifts per man-hour are, in ... parlance. As we get more experienced we expect to put in cer... kinds of incentive programs as well, to see if we can heig... those numbers even further, so there's an incentive for everyb... to come up with ways to improve the procedures.

To control the terminal, you have to control the documenta... In Seattle and Tacoma, we control the clerks.

The labor and supervision for loading and unloading are crit... Our people are out there, all day every day, supervising ... truckers on the job. The criterion that we've established is ... all truckers have to be in and out of the facility in less tha... minutes. In fact, in most cases they're out in less than 10 min...

There's a lot of talk about lift equipment. We operate ... facilities with six different kinds of equipment. From experie... I can report that the effect of lift equipment and yard de... on productivity are much less than the effect of labor prac... and agreements, the quality of people you have, the way th... treated, and the quality of supervision. The control of docu... tation and gate procedures are also more important than term... design and equipment in achieving productive operations.

Preplanning is an important element of productive operat... In Seattle we have terminal coordinators who work with ... steamship lines, the port, and railroad to plan ahead as be... they can as to what we're going to take in each day eastbound... what we've got coming westbound, and who try to schedul... business as best as they can so that we can get good product...

at the terminal. We make sure that every load that is accepted goes out that night. Eastbound loads are never held over. Nor do we accept more than we can handle.

Cycle loading and unloading at track side is a key element. That way the trucker and the container-shipping line are assured that that chassis is going to get back to them. It's not going to get lost; it's not going to end up being dropped in a rail yard.

Expedited gate procedures are also important. Computer-to-computer transfers of data, the use of a common trailer interchange report, the use of manifests rather than individual bills—all of these cut down on the amount of actual paper that needs to be handled. Improvements in labor practices are absolutely essential. Our single job category and rate of pay make it possible for people to work as gate inspectors one day and equipment operators the next. The variety improves the quality of the work accomplished, as well as providing management flexibility.

The best possible terminal layout is long tracks with maneuvering room in between.

An obstacle to improved rail-water containerized transportation is the incredible equipment imbalance. On the Pacific Coast, eastbound containers are full, westbound containers are empty. This tremendous waste of capacity has to be addressed to really improve productivity.

The flood of import container traffic for auto parts is making matters even worse. Motor carrier competition for the scarce backhaul is greater now than it's ever been and will continue to increase. These areas hamper intermodal development because they have a tremendous impact on the profitability of the business.

Discussion

Hugh M. Lacey, Sea-Land Service, Inc.: None of our speakers has identified a technological breakthrough that is going to improve productivity dramatically. Nor have they cried out for a massive injection of capital. Instead, they have stressed the human side of the business, the need for steady labor, better management, and better communications.

This discussion was moderated by Hugh Lacey, retired vice-president of Sea-Land Service, Inc.

single-facility storage yard.

John Gray stressed the human side of the business. He underscored the importance of planning as well as some nuts-and-bolts basics such as advanced notification, flexible hours, and different work rules.

Robert Senecal, Metropolitan Stevedore Co.: How can the innovations in labor practices that have been suggested actually be implemented?

Hugh Lacey: There is no patent formula. Steady labor, flexible work rules, and straight labor each may work in particular circumstances.

David Burns, Burlington Northern Railroad: Our facility at Seattle is an interesting case in point. Most Burlington Northern facilities include railroad clerks who do the paperwork. The people who do the lifting on and off and the people who do the hostling are mostly nonunion contractor employees. Management had to decide what kind of a work force to install at Seattle. Against this backdrop, the teamsters thought the terminal should be a teamsters' facility; the longshoremen thought it ought to be a longshoremen facility.

In considering options, a consensus started forming in management that it would be better to be union rather than nonunion at Seattle, provided that union affiliation would not deny management essential flexibility to operate productively. Discussion centered on a composite work force with some union affiliation, but who were not railroad employees. Today at the Seattle International Gateway, the Brotherhood of Railroad and Airline Clerical Employees represents all the employees, who are employees of the terminal operating contractor.

These former railroad workers lost pay, job security, and benefits. What they got out of it was, in their own words, "ownership of a job." What do they mean by that? The contractor can throw them out tomorrow. With the railroad, the workers pointed out, you have all manner of guarantees and a grievance procedure.

Yet stringent work rules led to seniority bumping as the railroads trimmed forces and operations. With the constant bumping, job turnover was high. Job occupancy was transient. With flexible work rules, the workers feel they own their job as long as they do it right. They feel needed and appreciated.

John **Gray, Intermodal Management Services, Inc.:** The Seattle workers who left the railroad to work in the intermodal terminal could have opted under railroad union contracts for jobs for life, regardless of whether they worked or not. The majority of workers who switched were relatively young. They opted for productive jobs where they could contribute and take pride over a guaranteed wage. These workers have no guarantee with me, and I really don't have a guarantee either, because I operate on a 30-day cancellable contract with the railroad. Yet their productivity is excellent, as good as any facility in the country, and the morale is very, very high, because there's value to the job; they like what they're doing; they're treated like human beings.

David **Burns:** All the Brotherhood of Railroad and Airline Clerks could see in the railroad industry was decline. With the Seattle International Gateway, the union has increased dues-paying members.

Michael **Gaffney, Cornell University:** Under the single job classification arrangement, what means are there for the work force to have equitable treatment in terms of reassignment?

John **Gray:** Everybody basically has the same seniority date, so you can't use seniority. Take away the job classification and rate of pay issues, and conflicts disappear. When conflicts about shifts or other matters do arise, we try informal methods ("Why don't the day and night workers swap shifts after 6 months?" for example). The informal methods seem to work better than rigid postings.

Keith **Christian, Port of Seattle:** As the work force changes over time, you will get different levels of seniority. Do you think this will complicate the situation?

John **Gray:** Most of our workers are young. They have good jobs, and have the capacity to do a lot more than they're doing now. We do about 8,500 lifts a month at that terminal. That same crowd can handle 10,000, 11,000, 12,000 lifts without any problems. This is likely to be a very stable work force.

know if it's possible or not. The only way you can afford a steady worker is if the worker can perform more than one task. A well-trained, steady work force makes a lot of sense, for more reasons than just productivity. I think there's a definite emphasis on safety. Also, the guy can begin to know where everything is and how it works. But there's no magic wand to accomplishing this. It's something our industry has to go after in the context of collective bargaining.

If you got all the terminal operators in Los Angeles/Long Beach together and asked if they want steady labor, there'd probably be some that say no. There has to be room for the employee to take a steady job if he wants to. There may be some terminal operators who don't want that because of fluctuations in business or whatever.

William Webster, University of California at Berkeley: We've heard a lot about conditions on the West Coast. I haven't heard much about the East Coast.

Roger Giesinger, Virginia International Terminals, Inc.: We operate three terminals in Norfolk. We are going to strive for flexibility in the next round of labor negotiations. Terminal operators need both guaranteed people as well as casual labor in order to handle surges in work. Another aspect of flexibility is longer hours to operate the terminal on a straight time basis and not on overtime. I think, in doing that, you create jobs.

Rudy Rubio, International Longshoremen's and Warehousemen's Union: Labor has points of view as to how some of these issues should be addressed, which requires that management and labor together look at these problems. The agenda of this meeting provides for this by means of workshops. A more balanced view of these subjects may be contained in the reports of the workshops.

Clifford Sayre, E. I. du Pont de Nemours & Co.: Is the labor reduction in force situation pretty much the same on the East and West Coasts?

Hugh Lacey: They're quite different. One of them seems to stress the status quo; the other has a great deal more flex to it.

Lee Lane, Association of American Railroads: The issue of incentives for improving productivity has at least two dimensions, incentives to encourage individual output and incentives for output of the facility as a whole. Could someone elaborate on incentives to achieve these different aspects of productivity?

John Gray: Our incentives are geared to improvements in unit productivity, and that's better than trying to pick out individuals.

Anthony Petrizzo, Maersk Container Service Co.: I wanted to comment on aspects of the human element. As regards West and East Coast differences, there is a significant age difference. Longshoremen on the East Coast average about 57-years-old as contrasted with workers a generation younger on the West Coast. There's a different educational level and a different work ethic. Years of working independently in a flexible work environment possibly mean more to the younger group.

Sometimes it's helpful to look outside our own industry, to see how other industries handle the human element. We can't look just within ourselves and our own industry.

Hugh Lacey: One of the things we don't do enough of is the exploring of what the other guy is doing. The attitude in our industry is, "Who cares?" Other papers in the proceedings do consider innovations tried elsewhere. As long as we're looking at a human problem, we need to look at different human approaches, because obviously ours hasn't worked so well up to now.

John Gray: My company will probably implement an agreement similar to that in Seattle at another location, involving a large group of people with an average age of about 52. Next year I'll be able to tell you how that worked out. Some of the concepts we use follow the Japanese model, and it works.

L. P. Robinson: The age of the worker is not that important. We're not talking about pushing a button on a worker's back to make the worker speed up. We're just talking about more consistent work and better planning. Another side of the human element is the quality of management supervision. We've abdicated much of that, I think, to labor.

Asaf Ashar, Louisiana State University: Perhaps a long-term solution is to unify all the elements into one transportation company.

Rudy Rubio: I don't know much about trucking, but there was something in what Mr. Curry said that made a lot of sense. My union's point of view is that if commitments are to be made by unions, then there also have to be commitments on the part of management. Management in trucking seems to be slipping away. Without management commitment, how can there be labor commitment?

Hugh Lacey: You can have fast trains and big yards and still not be able to move cargo in and out of the gate. Motivation is all important. Some time ago, Sea-Land embarked on a product improvement-oriented self-analysis/motivation program termed "Buy Analysis." At first it was difficult to apply the concept to a service business. However, we put a tremendous amount of time and effort into the challenge. The result was about 690 projects with savings of $50 million offered up by grass-roots workers. The target all along was the first-line supervisor and the worker. We've been quite happy at the participation we've had from most of our union people, including the clerks and the machinists. We haven't had as much luck with the longshoremen because there's no path of communication for mutual interest. We've decided to expand that concept and move toward Japanese-style quality circles. We're relying increasingly on participative management because we have found that if you have a problem, the cause and the cure are often with the first-line supervisor.

Clifford Sayre: We have been discussing productivity in various elements of the transportation system. We've been blessed in this country with an overabundance of capacity in all of the elements of the transportation system. One of the things that has a big influence on productivity is capacity utilization. Various elements of our transportation system are now starting to rationalize themselves, for different reasons. At some point that is going to have an impact on the performance of the total system. Robert Curry's real message today is that we may find the pinch

point between capacity and productivity first in trucking, as one of the very key elements of the system.

Marty Frates, Teamsters Local 70: How has deregulation affected the situation in the trucking industry?

Robert Curry, California Cartage Co.: Deregulation has materially affected the industry. Six of the top 15 truck lines in the United States have been forced into employee buyouts. We're like people in the jungle; we're eating each other.

When I grew up in this industry, you had a tariff book and you had rates. Everybody was equal. That's not the case today. I'd hate to be a traffic manager. One company may offer a 42 percent discount today. Another finds out about it and offers 43 percent the next day. The largest and strongest companies will survive. The long-haul irregular route carriers will survive also because they're specialized. The rest of the industry is not going to survive, and that's all there is to it. If you're going to survive, you'd better be a big guy or a specialist. The other crippling factor is the national insurance crisis. This industry's problems will be solved in the long run by attrition.

Marty Frates: Deregulation of trucking has also affected safety. Trucks are no longer being maintained adequately because the revenue isn't there for that.

Robert Nolan, International Terminal Operating Co., Inc.: Has any thought been given to the effect on marine terminal productivity of the lack of a regular work force on board ship?

Robert Fall, Sea-Land Service, Inc.: From the ocean carrier's perspective, the total transportation system is undergoing a very rapid evolution. In the past, we've concerned ourselves with moving freight from port to port. Today, the impetus is on intermodalism in the total transportation system. This may mean redesigning the terminal, moving it closer to a railhead, or establishing unit trains. The ocean carrier is pressuring the total system. For one thing, he's building and operating larger-capacity ships.

Technology Development and Application in U.S. Marine Terminals

FRANK NOLAN, JR.

The traditional marine terminal, equipped with labor, rope-nets, slings, crowbars, and hand trucks, was phased out during the 1940s as the wood pallet and forklift truck came into general use. This was just the step in the rapid evolution of cargo handling. It was followed by the through shipment of unitized loads, the introduction of roll-on/roll-off systems, and finally the onset of containerization.

Each change evolved from a primitive form to the more sophisticated result: the pallet from the cargo tray; the modern container from the many reusable military containers in use during World War II; the straddle carrier from the lumber carrier of the 1930s;

Frank Nolan, Jr., is associated with Container Transport Technology Corp. He worked for International Terminal Operating Co., Inc. for many years and retired as vice-president of engineering. Mr. Nolan recently chaired a subcommittee of the Marine Board, which appraised technology development and application in marine terminals. His paper summarizes the work of that group.

and the container crane from the many earlier shipside gantry crane types.

The overwhelming motivation for the evolution was profit and the need to remain competitive. Skyrocketing labor costs demanded technological changes to improve productivity.

In this perspective one may conclude that there is nothing new under the sun, but each change along the way required departure from tradition and a willingness to step into the unknown or at least the unproven.

The energy crises of the 1970s followed by high-interest rates, the strong dollar with resultant trade imbalances, and the recession of the late 1970s that brought on intense competition forced the maritime industries to reduce staff, eliminate research and development (R&D), and even cut back on maintenance and repair in order to survive. Unfortunately, these are the very expenditures that are necessary to sustain and advance technology, and to maintain a competitive posture. Not only had private industry curtailed R&D expenditures, but the Maritime Administration (MarAd), a significant contributor to R&D, has been under severe government pressure to pare expenditures in the wake of enormous budget deficits.

To aid MarAd in assessing the present status of the maritime industry, the Marine Board of the National Research Council formed the Committee on Strategies to Improve R&D in the Maritime Industry, which in turn formed work groups to evaluate each segment of the industry.

The objective of the Marine Terminal Work Group was to document R&D and to identify opportunities for improvements.

To carry out this assignment the work group developed four general tasks and assigned each task to one or more individuals. Eight papers were prepared, discussed in committee, revised, and finally worked into a single preliminary committee report.

The report includes the following:

- rail operator's intermodal assessment;
- civil engineering aspects, vis-a-vis deep-water requirements;
- labor productivity and manning levels;
- equipment and facilities;
- management systems; and
- bulk cargo terminals—state of the art, and R&D assessment.

inated these roadblocks and now permits a single entrepreneur to provide door-to-door transportation. This will intensify competition among all transport segments along alternative routes and will tend to align transport along the least-cost path, thus opening the door to the systems approach to transportation.

THE RAIL PERSPECTIVE

The recent introduction of double-stack cars has opened new vistas for long-haul, heavily traveled rail routes. Rates have come down about 30 percent in these operations. Most double-stack volume has been the result of marketing by steamship carriers. Railroads have not encouraged its growth as profit margins are very small. Problems foreseen include right-of-way maintenance costs, bridge clearances, equipment service life, and cost of installing interbox connectors on some types of cars. As growth of double-stack service takes place, there will be pressure for construction of new, efficient intermodal rail terminals, designed to handle the rapid high-volume through-put associated with the marine interface.

CIVIL ENGINEERING ASPECTS

Government cost-sharing policy for harbor improvements, as well as the economic pressure for deeper ships, will affect marine terminal costs. There are existing techniques for protecting terminals against subsidence when berths are dredged beyond their design depths. In the future, marine terminals will be expected to bear the cost of structural improvements as well as the cost of initial and maintenance dredging. These costs will likely be a factor in defining the least-cost route in the transport chain.

LABOR PRODUCTIVITY AND MANNING LEVELS

Generally speaking, labor has not impeded the development and application of most competitive technology. However, in those ports served by the International Longshoreman's Association (ILA), longstanding labor and management agreements have denied much of the cost-saving benefits of new technologies to the terminal operators. Manning levels of shipside gang units in these areas are two to three times the size of those in most areas of the world, and crane productivity in all areas is confined to a narrow band. In spite of this disadvantage terminal operators have continued to be innovative. The resultant loss of potential profitability has made it impossible to pass savings along to the terminal user. This, too, will affect the least-cost route determination.

EQUIPMENT AND FACILITIES

Container size and capacity changes that introduced the 45-foot container and the 24-ton, 20-foot container provide shippers with optimum equipment for certain cargoes, but an entire series of problems develops down the line with existing equipment designed to prevailing international standards. It is expected that these new containers will continue to be used in closed systems that are economically justified.

High- and intermediate-density, yard-stacking systems have been introduced, employing straddle carriers with three-high stacking capability, rubber-tired yard gantry cranes, and rail-mounted yard gantry cranes. Some of these systems will permit a high level of yard automation, such as that employed by Matson at Los Angeles.

Improvements have been made in gate design, permitting efficient document transfer and voice link from truck to tower. Deck-lashing systems, though underutilized, can eliminate the costly installation and removal of lashing and securing devices. Equipment has been developed to permit the radio transmission of data from portable units to update computer data files.

in the near future. ... tiveness of machine-readable labels to identify equipment and its cargo at selected stations. In time it is expected that a complete, three-dimensional yard location plan can be automatically taken to locate every piece of equipment in the container yard. Automatically logging equipment in and out of the gate, as well as on and off ships, is also envisaged.

Standards must be developed and established for the coding of required information to facilitate its transfer along the transport chain. This, however, is outside the control of the marine terminal operators. It is a problem that can best be addressed by the maritime industry as a whole in cooperation with standards organizations.

BULK CARGO SYSTEMS

Most of the technical problems uncovered in the analysis of the intermodal marine container terminal were found to be present in bulk terminals—huge capital requirements, no dependable future volume to amortize investment, and curtailment of R&D funds when profits are squeezed. Enormously expensive facility expansion during the recent energy crisis is now surplus as world coal trade slumped after the crisis. Vast strides have been made in improving productivity in recent years, but little is being done now to expand the application of technology or to develop new technology.

SUMMARY

The Marine Terminal Work Group envisions the need for continued and expanded development and application of existing technology in pursuing the system concept. The historical parochial outlook within the marine terminal industry must give way to the overall economics of the transport chain. Recent government deregulation of the transportation industry has opened the door

the transportation entrepreneur to provide door-to-door ser-ɜ. The marine terminal industry must be prepared to react lislocation brought about by competitive adjustments in other :s of the transport chain that might directly affect the routing :argo. Innovative operators will be able to control their destiny influencing system economics in their favor.

Γhe single greatest deterrent to innovation is the huge capital lay required to reach the ultimate level of automation, and the :ertainty of the end result.

While the marine terminal industry is a highly competitive ɜ, its economics are borne equally by all operators, foreign and nestic. However, any inefficiencies suffered in U.S. ports may versely affect the competitive position of exporters competing Third World business.

Technology available to marine terminals in the United States ıs advanced as that available to the world as a whole.

Marine Terminal Operations in the United States

DAN RAYACICH

"Born in the U.S.A." is the theme of a popular song, and most tainly a true statement about containerization. Cargo-handling ɪts were the largest single expense in the carriage of ocean-borne ·go, and containerization was the made-in-the-U.S.A. solution. .e new technology was soon exported overseas, and its inherently ɔerior productivity led to worldwide acceptance. It is ironic ıt we are meeting here out of concern that container-handling ɔductivity in U.S. ports may have declined below levels achieved ɜrseas, that the teachers may have been outstripped by their mer pupils.

Containers cannot normally be delivered directly from shipside the next link in the intermodal transport chain (truck, rail, site CFS [container freight station] or rail facility), and vice :sa. The container terminal is the temporary repository for in-ɪnsit storage of containers while notifications are being sent to

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avoiding ship delay at the berth, is also an important function of a container terminal. The operating productivity, as containers are handled and rehandled in the course of passing through the terminal, is usually stated in terms of containers handled per shift, per crane, or in terms of annual container throughput.

CONTAINER-HANDLING SYSTEMS

From the earliest days of containerization, not much more than 30 years ago, the pioneering American container carriers developed different container-handling systems. Sea-Land decided on the chassis system, and it is still its method of choice. Matson Navigation Company preferred a stacking system using straddle carriers, and that is still its principal mode of operation. Equipment manufacturers promoted still different systems by developing specialized machines for handling containers. PACECO's transtainer was the basis for a high-density stacking system commonly called the transtainer system. Comparable machines produced by other manufacturers are called transfer cranes, rubber-tired gantry cranes, yard cranes, and so on. Forklift manufacturers have equipped their very large forklifts with spreaders to handle containers from their upper corner castings and with high-lift capability to enable stacking of containers three high. The corresponding container-handling systems are called port packer systems, top-lift systems, and the like. The sidepicker, another variation of the forklift, came into common acceptance as a supplementary machine to handle the stacking of empty containers. Also, there are combination systems; for example, one Bay Area terminal uses port packers for the ship operation, transtainers for receiving and delivery, and a sidepicker for stacking empties. The latest development is based on rail-mounted yard cranes that span 20 container rows and operate in semiautomated mode by means of computer control systems, as exemplified at the Port of Richmond.

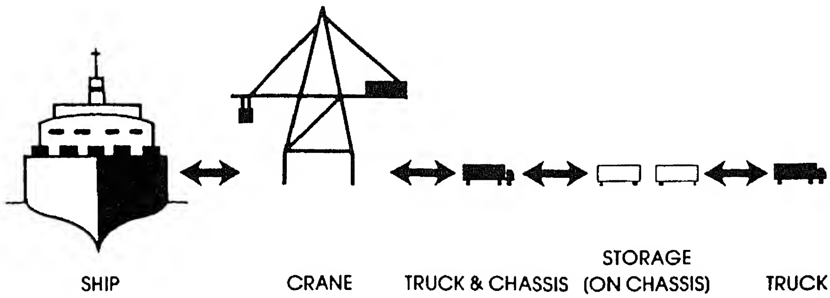

FIGURE 1 Truck and chassis container-handling system.

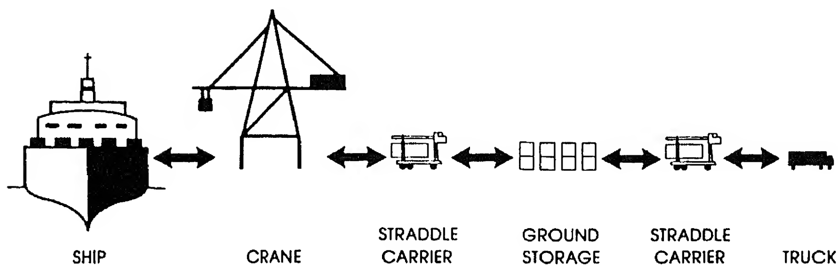

FIGURE 2 Straddle carrier container-handling system.

Currently, chassis systems are used in 46 percent of the container terminals in the United States, and 54 percent use stacking systems that are quite widely distributed among the types just discussed.

Which System Is Best?

Figures 1 through 5 depict typical container-handling systems. Each has advantages and disadvantages. If one should ask hands-on operating personnel which system is best, they tend to support whatever system is provided in the terminal in which they work.

Often, generalizations are made concerning the basis for selection of a given system. For example, if backup land is cheap and plentiful and paving costs are moderate, a chassis system is said to be the most advantageous. If land is costly and limited, a stacking system might be the choice.

FIGURE 3 Travel crane container-handling system.

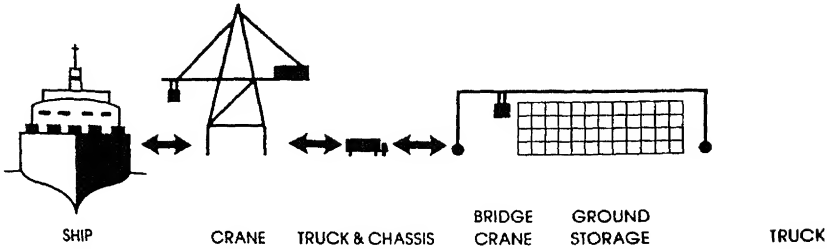

FIGURE 4 Bridge crane container-handling system.

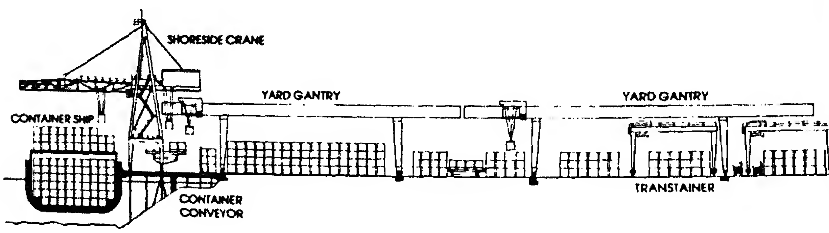

FIGURE 5 Overhead container-handling system.

The logical approach in determining the most suitable container-handling system is to apply cost minimization techniques, taking account of the following factors:

1. Equipment expense
   - initial capital cost
   - annual operating costs
   - annual maintenance and repair costs

2. Land and infrastructure expense
   - initial capital cost
   - construction costs
   - annual maintenance and repair costs
3. Labor expense and overhead

Other considerations are the expected cargo (container) flows, traditional labor practices, safety, and capital requirements and limitations. All these factors affect the economic feasibility, which should be the basis for selecting a particular system.

It follows that the traditional measure of productivity should be used; namely, productivity = cost/containers handled.

Public Versus Private Container Terminals

Notwithstanding that we consider the United States to be a bastion of free enterprise, about 88 percent of the container terminals in this country are provided by a public body, a port authority at the city or state level. When at the state level, in Hawaii for example, a single port authority controls all ports in the state. More commonly, the port authority's jurisdiction is at the city level. For example, all of the following port authorities in the San Francisco Bay Area are independently functioning port bodies, despite their proximity:

Port of San Francisco	Port of Oakland
Port of Richmond	Port of Redwood City
Port of Sacramento	Port of Stockton
Port of Benecia	Port of Alameda

Comparable groupings of autonomous port bodies can be found in Puget Sound, Los Angeles/Long Beach, Chesapeake Bay, Galveston Bay, and the Mississippi River.

A container terminal within a given port can be:

- a common use facility, available to any vessel;
- a preferential use facility, usually available to several specific lines, but available to others if not fully occupied by the preferential users; and
- an exclusive use facility, usually placed under the control of one line. However, that line often has the option of bringing in others as customer accounts. An exclusive use facility can be very

The description of operating procedures that follows is quite general, describing operations activities that most container terminal operators would find familiar, while probably not applying entirely to any particular terminal. The hypothetical terminal is assumed to use a stacking system and to have a current type of interactive real-time computerized information system with computer displays and terminals at key operating positions.

Operations Control Center

The necessary coordination and control of all container terminal activities are handled by personnel at the operations control center (OCC). There is a flow of information between OCC and all other functions of the container terminal concerning container movements and status. Often, key personnel of OCC are located at elevated offices or in an operations tower well above the container stacks, for unobstructed views of the container terminal. From that vantage point, they are readily able to confirm by visual observation the container-handling activities that are being reported to them by telephone, pneumatic tube, radio, computer, and other means of communication.

Export Container Flow to Terminal

Well in advance of a vessel's scheduled arrival, the steamship company will set up its documentation for export movement of containers to be loaded on that vessel, and corresponding documentation will be organized at OCC. Booking information is sent to the terminal, accompanied by requests to release empty containers and chassis to shippers. Prior to the vessel's arrival, the steamship company sends an inbound stow plan to the terminal that identifies the containers to be discharged from the ship and consequently indicates which container slots on the ship will be available for loadback. The freight projection (provided by the booking department) identifies expected container types, the

ength, and the weight of the export containers to be received from the shippers for that voyage.

This flow of information enables OCC to implement its planning program toward efficiently managing the expected flow of export containers through the terminal and onto the ship. Space is reserved in the outbound marshalling area for the planned export load. The gate is advised to route truckers bringing export containers for that sailing to that portion of the stacking area set aside to receive these containers. The plan is updated as changes take place. Export CFS and rail containers are coordinated into the plan.

An outbound stow plan is prepared which relates yard container locations to ship stowage positions, after which all is in readiness for the ship-loading operation.

There is a point where a ship outbound stow plan should be stabilized—especially when a terminal is handling several vessels concurrently—by instituting a cutoff time, after which no further export containers should be received for that ship's sailing.

Vessel Discharge Planning

With the ship inbound stow plan as reference, Operations Planning will develop a ship discharge plan, assigning containers to be discharged to specific locations in the stacking area. Also, the unloading sequence is formulated, with due regard for containers requiring special handling.

If there are overstow containers, they must be removed or relocated to gain access to the containers to be discharged. They are included in the new ship outbound stow plan to minimize outturn problems at subsequent ports of call.

Seaworthiness Aspects

The outbound load plan provides for the shipboard positioning of the export containers with due regard for the seaworthiness of the ship and its cargo, as well as for the efficiency of cargo-handling operations at succeeding ports of call. The seaworthiness factors are:

- ship stability, as defined by the location of the center of gravity;

- container support on all four corners for ondeck containers; and
- special requirements: placement of reefer containers, location of hazardous cargo containers, adequate column height of below-deck containers to ensure hatch cover clearance, and maximizing containers for maximum revenue.

The Gate Complex

The gate complex is the control center for containers entering or leaving the terminal by truck. In-gate truck lanes are equipped with platform scales for weighing containers. In an up-to-date terminal, the weight readings would go directly to the gate clerk's video display terminal. The gate clerks ascertain that the trucker's documentation is in good order, inspect the container and chassis for damage, and prepare the equipment interchange report. Entering truckers are directed to drop-off or pickup areas for their containers. Exiting truckers are required to show their authorization to haul away containers or equipment and that Customs requirements have been met. Ideally, gate clerks use the interactive capabilities of their computer terminals to verify container availability, to ascertain locations of containers and equipment in the yard, and to determine whether charges or assessments are to be collected. In general, the gate clerk uses the computer system to key in data and extract information toward accomplishing an orderly transfer of containers and equipment between truckers and the terminal.

During peak periods, most gate systems cannot process trucks fast enough to prevent long truck lines and extended truck waiting time. A great deal of gate delay relates to truckers arriving with inadequate documentation. A precheck activity would rapidly determine such documentation deficiencies, and those truckers could be turned around or separately processed and taken out of the truck queue, thereby reducing delay time of other truckers at the gate.

Container Flow

Having developed detailed plans for discharging import containers from the ship and loading back export containers, the actual physical act of making these container moves is quite straightforward. Likewise, once procedures are established for receiving and delivery of containers, and proper planning methods are followed, the interchange of containers between truckers passing through the gate and the stacking area is not complex. Details concerning the physical handling of containers will not be presented here.

The primary container flows are:

- import container flow;
- export container flow; and
- flow of recirculating empty containers, from consignee to the terminal and then to the shipper.

Also, there would be container flows to and from an onsite CFS and an onsite rail facility, if the terminal is so equipped.

THROUGHPUT

Throughput is the volume of container flow from shipboard, through the container terminal, and out the gate, and vice versa. If throughput per crane is used as a criterion, American container terminals would compare poorly with overseas terminals. For example, a study by the Port of Seattle showed the following per-crane throughput for leading California ports:

- Oakland—39,000 TEUs;
- Los Angeles—38,000 TEUs; and
- Long Beach—32,000 TEUs.

By comparison, the container terminal at Pusan, Korea (a four-berth, eight-crane facility) has a per-crane throughput of about 100,000 TEUs per year. What accounts for this vast difference?

The basic cause is that American container terminals are underused, sometimes grossly so, because we have such an abundance of terminals for the volume of cargo available. Primarily, this situation resulted from the intense competition among ports in the same region for what each perceived as their share of the container market. Remember, each of several port authorities in a given port region is autonomous.

profits. They may be charged with generating economic activity. Perhaps, desire for the right image for their port is the motivator—comparable to the lengths some cities go to attract (or retain) a major sports franchise. These are among the circumstances that may have led to overbuilding and, consequently, underuse.

Korea, on the other hand, has a single port authority for all ports, the Korea Maritime and Port Administration (KMPA). The KMPA's centralized planning division has done a good job of matching container terminal construction with container volume passing through the Port of Pusan. The Pusan container terminal is a common-use facility, and most container ships calling there are routed through that terminal. The result has been excellent use of their container terminal and high throughput.

No doubt, like comparisons can be made of European and other major overseas ports, but that information will be presented by other participants of this symposium.

It is fair to point out that for the first 20 years of the containerization revolution, the rapid growth of container volume exceeded forecasts year after year, and container port facilities were strained to cope with those volumes. Although some of the rosier growth forecast scenarios have not been realized in recent years, and the momentum of building container terminals may have gone beyond today's demand, there is a definite bright side to our current situation. American ports now have the reserve capability of absorbing a substantial increase of container volume without a large amount of additional building. When growth catches up with capacity, as it inevitably will, the improvement in per-crane (or per-berth) throughput should be considerable.

CONTAINER TERMINAL COST BREAKDOWN

The variety of systems used, the degree of use, local labor practices, and the like, all tend to produce cost differences among the various terminals. Nevertheless, there is a general cost trend, as is apparent from the tabulation in Table 1. This tabulation

TABLE 1 Proportional Cost Breakdown of 11 West Coast Terminals

Cost Category	Average	Range
Labor	38%	30-51%
Terminal lease	26	19-34
Gantry crane rental, capital cost of handling equipment, maintenance and repair, utilities and fuel costs	24	18-40
Overhead	12	7-14

was based on a recent analysis of 11 major West Coast terminals, of which approximately half were wheeled (chassis) operations and half grounded operations (using a container stacking system). Thus, the analysis reasonably matches the distribution of the various systems throughout U.S. ports. As can be seen from Table 1, labor costs are the largest single entry, and they are the most likely to be variable.

THE EFFECT OF WORK RULES ON PRODUCTIVITY

One hears a great deal these days about the need for greater technological development and mechanization in our basic industries in order to improve productivity, and for greater freedom from work rules that inhibit the most efficient use of the work force. Understandably, labor tends to resist such changes because of the resultant erosion of their members' work opportunity.

On the waterfront, labor generally has accepted the various changes presented by management in equipment systems, computerized information and control systems, and methodology of handling containers. However, manning and work rules continue to be controversial issues and these vary from region to region. Traditionally, employer groups want more say in the process of selecting steady men for the skilled positions, while the union leadership strives to broaden the opportunity for such assignments by means of work pools from which personnel must be drawn.

For many years, there have been different container gang sizes in different ports for the same ship. Arguments could be made for the larger or smaller gang size, depending on one's point of view. However, in most cases neither party is anxious to bring the

summary that would be considered objective by both sides. Reconciliation of differences will come from the collective-bargaining process.

Work rules do indeed affect productivity, and this is particularly apparent if comparison is made with overseas ports having drastically different laws and traditions than we have in the United States concerning labor and management relationships.

VIEWPOINTS CONCERNING PRODUCTIVITY

While in the final analysis productivity is defined by cost/containers handled, the indeterminable question is "Whose cost?" From the steamship company's viewpoint, the hourly cost of its ships alongside a berth is the overriding factor, while the stevedoring company is concerned about its direct costs.

The friendly wrangles between the stevedoring company and the shipping line are a familiar waterfront scene. Initially, the parties reach an agreement concerning the rates for loading and discharging cargo. Thereafter, the stevedoring company officials strive to perform that work in the most economical manner, within the bounds of their contractual obligations concerning cargo protection, safety, vessel schedule integrity, and the like. The shipping line, on the other hand, is concerned with vessel dispatch, special handling for valued customers, and so forth—in other words, in those aspects that would provide the most benefits for the shipping line, although they might unfavorably affect the stevedoring company's profitability and productivity.

To the port authority, the measure of productivity would be in terms of throughput per year, as port revenue is proportional to the throughput. The trucker would be concerned with truck turnaround time at the container terminal, as that would directly affect his productivity. Shippers and consignees view the matter in terms of the quality of service received from all concerned—the shipping line, stevedoring company, and trucker—and the cost of that service.

In conclusion, all participants involved in the cargo-handling process, or affected by it, have different definitions of productivity, reflecting their individual interests.

Application of Information Systems to Marine Terminal Operations and Productivity

NANCY FRIEDMAN

Advanced technology exists today that can substantially increase the productivity of marine terminals. These technological systems when applied to the gate, yard, apron, and container freight station (CFS) can significantly increase the efficiency of operations and allow for faster processing with greater safety. Today's competition between carriers, and the limited annual increase in freight volume, require management to evaluate thoroughly the impact of employing these new technologies.

There is an understandable reluctance on the part of marine operators to allocate resources for the development of new systems. Return on investment is typically uncertain. Market changes or dips in the economy can drastically change the results of cost/benefit analysis of any major system. At the same time, today's economics demand these innovations. Rationalization, intermodalism, and large 2,000+ TEU container ships require carriers to look hard at productivity-enhancing technology that allows them to reduce unit costs.

Barriers to innovation go beyond the capricious nature of the economy. The perceived resistance of labor is often used as an excuse for lack of innovation. On numerous occasions both East and West Coast longshore labor have worked with management to foster innovation, but in some cases new technology must be seriously considered even if no reduction in labor will result.

Another barrier to the adoption of new technology has been the inability of management to evaluate the life-cycle system cost and

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R&D resources from the various carriers has resulted in more thorough research and more prototype system testing than would have otherwise occurred with a single carrier. Sacrificing daily operations for system testing has been a problem in the past for individual companies. With one carrier testing a system for several other carriers, however, there is only a minor impact on operations.

In many industries the "automated data processing (ADP) mystique" has provided a roadblock to operational innovation. Traditionally ADP is a service arm of the line organization, but this is changing. Data processing managers often control major business decisions primarily because the operations managers do not have the experience to evaluate thoroughly the position of the data processing department on new technology. This is changing as well. Most operational managers are now sufficiently well versed to challenge or question costs and timeframes set by their data processing counterparts. User friendly personal computer-based models allow non-ADP managers to evaluate a proposed system thoroughly.

Finally, the day-to-day challenges facing the maritime manager create a workload that allows for limited strategic planning and testing of innovation. The new project of today quickly takes a back seat to the operational problems of today.

Confronting these impediments, the maritime industry is forging ahead to identify and evaluate emerging technologies. In the remaining pages, I discuss four major areas where information technology advancements, proven in other industries, are being applied in U.S. marine terminals. In most cases, the proposed systems are introduced into operations through a series of evaluations and reviews. Figure 1 on the following page outlines the approach taken most often. Those who successfully employ the innovations adapt new ideas arising from day-to-day operations or transfer technology from other industries. The systems are then modeled, and if they show promise, a preliminary design is made. The design is evaluated and further modeled as part

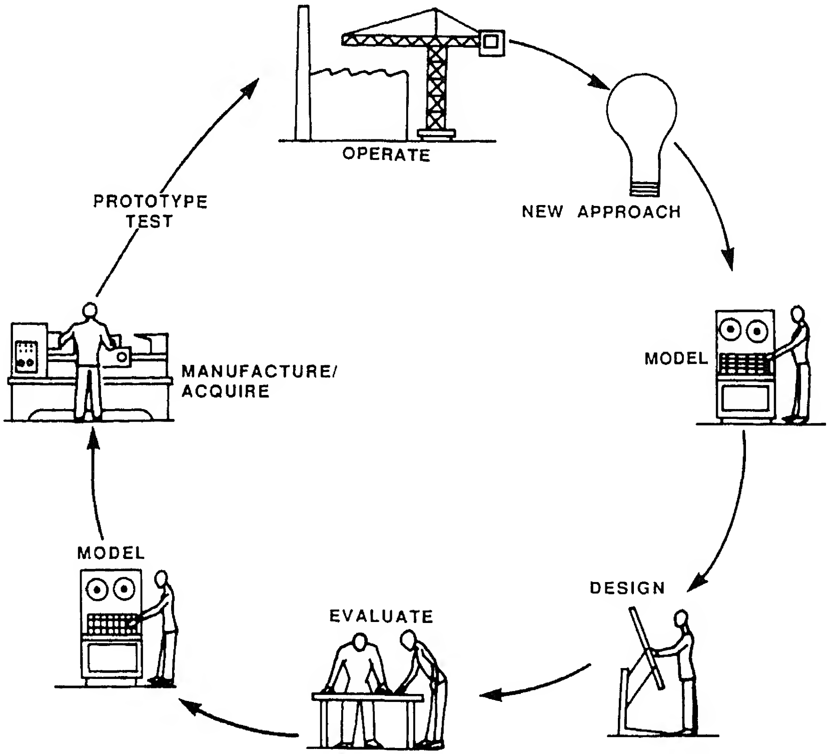

FIGURE 1 Technology introduction.

of an integrated system. When a decision is made to proceed, the system is manufactured or acquired and prototype tested. If the testing and associated cost/benefit analyses are favorable, the system is put into full-scale operation by the terminal operator.

AUTOMATIC EQUIPMENT CONTROL

In a modern marine terminal a ship may discharge and load 1,000 containers in a period of 24 hours. During that time there may also be 900 gate moves, 200 containers moving through the CFS, 100 containers moving into or out of maintenance, and 1,500 moves to and from parking locations in the yard. Conservatively, that would account for 3,700 transactions occurring in the terminal in a 24-hour period. As a result there would be

3,700 opportunities for productive movement of equipment; conversely there would also be 3,700 opportunities for mishandling, loss, or delay. In this example, the terminal operator would need the capability to identify the equipment number associated with the 3,700 transactions. In many cases additional data concerning such factors as location, destination, size, hazard, or internal temperature are also required. Automatic identification systems are available to provide the reliable equipment identification data just described. The benefits of automatic identification to the marine operators include:

- improved gate flow;
- quicker freight turnover and response time;
- more efficient land usage;
- quicker document generation;
- more accurate inventory control; and
- improved customer service.

Information technology to improve equipment and product control has been developed in many sectors of U.S. industry. For instance, blood banks use highly reliable bar code technology to segregate blood types. Bar code systems operate most effectively in controlled environments when relatively small amounts of data need to be captured. Optical character recognition is used extensively in documentation handling. The Internal Revenue Service has employed the technology for the 1040 EZ forms. Bar code and optical character recognition are two automatic identification systems that have been tested in the marine environment. They have been proven to be environmentally sensitive and application restrictive. They do not justify the significant financial investment required to support an equipment control system for the maritime industry. From these tests the industry has better defined the specific requirements for a system that would provide real-time identification of all marine equipment.

Radio frequency (RF) microcircuit systems may meet these requirements. Among other objectives, the RF automatic identification systems were developed to address the environmental issues faced by marine operators. The systems are ideally suited for operation in a harsh, outdoor environment. Nonconductive materials such as grime, snow, and rain, which intrude between

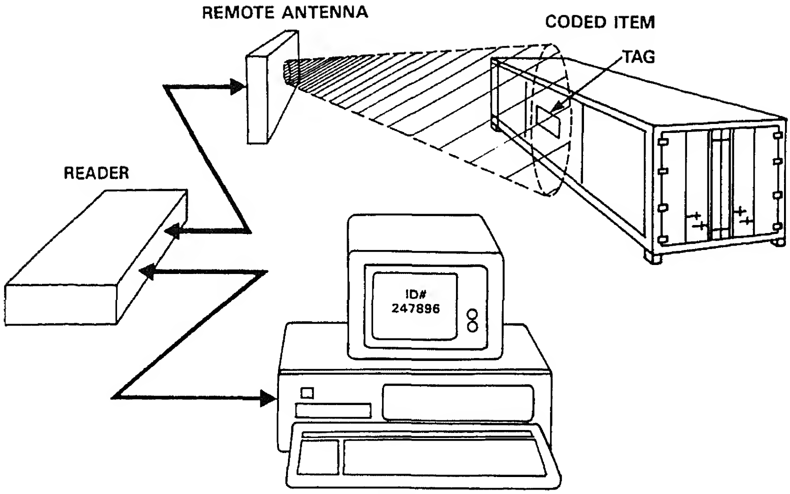

FIGURE 2 Radio frequency system components.

the interrogator and transponder, do not appear to affect operation of the system. The readers or antennas can be buried beneath asphalt to keep them free from vandalism, accident, and weather. The tags are rugged and not affected by dirt, and the life of the equipment is estimated at over 10 years.

RF systems offer high-speed, remote electronic identification of equipment. The system consists of transponders, or tags, an interrogator with an antenna, and a computer interface. The heart of the system is the tag, powered either by a battery or an RF beam from the antenna. This RF power is converted to run a custom integrated circuit chip. Each tag can have a unique code that is related to the object to which the transponder is attached (see Figure 2).

The electronic components of the transponders are enclosed in rugged packages that may be as small as a credit card. Because of the small number of parts used in the transponder, its rugged construction, and the low power level at which it operates, the transponder's life should equal the shelf life of its components. The physical characteristics of the interrogator and antenna vary

from vendor to vendor. One interrogator can drive a multiple number of antennas via coaxial cable.*

High-speed requirements appear to present no difficulty; transponder-equipped objects can be identified as they move by the interrogator at speeds over 100 mph. For system applications such as containers, RF power levels are 1,000 times below the limits established by the Occupational Safety and Health Administration for employee exposure. In the past, a primary obstacle to implementation of an RF system has been the price of the transponder. However, the price has dropped dramatically in recent years from $1,200 per unit to under $20 per unit in large quantities. It is expected that another significant reduction in the price of the transponders would occur if RF systems were adopted for industry-wide use.

One application for RF systems is monitoring containers. The system can track containers entering and leaving the terminal through the gate or as they pass scanning points in the yard. Mobile operators can be used to conduct a secondary check of container locations. Antennas may be mounted in the ground or overhead on straddlers, gantry cranes, transtainers, and portainers. RF systems can also be used for inventory control of chassis, motor generator sets, or yard equipment. Not only will the data collected be accurate, but it is virtually assured that the data will be collected. This is a significant problem in marine operations.

Recent advances in microwave technology include a tag that can be read or written to. These tags contain 4,000 characters of data and can be updated as they pass antennas. This capability is beneficial when a prepositioned data base does not exist or when product data such as history, maintenance requirements, or quality assurance procedures are best kept with the product. This capability could also be used to identify the contents of a container or to identify which container is on a chassis when only chassis are tagged.

Another near-term system that may address equipment identification requirements is voice recognition technology (VRT). VRT may be used as a stand-alone system or integrated with other technologies. Voice systems use pattern recognition similar to that in bar code systems, but instead of an image, the computer

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* Proceedings, Scan-Tech '84, The Material Handling Institute, Pittsburgh, Pennsylvania, October 1984.

recognizes words in a preprogrammed vocabulary. In operation, a user speaks into a microphone. The machine recognizes words or phrases and then converts them into electronic impulses for the micro- or host computer.

Observers of this technology foresee a continual evolution of product capability. Discrete and connected-word systems are economically viable today, and continuous word systems are becoming less expensive. The accuracy of these systems is also improving, with even the less expensive units having the accuracy rate of 85 percent. High-performance units operate at an accuracy rate of 99.5 percent. Figure 3 shows a wide variety of equipment control technology currently under evaluation by marine operators. When properly integrated these systems can greatly assist in the automatic capture and processing of marine terminal data.

Even when the costs remaining and technical issues relating to automatic identification have been addressed, one major barrier still remains—that of standardization. We are rapidly approaching the time when standards for automatic identification equipment (AIE) will be essential. In the maritime industry, the benefits of AIE would be significantly reduced if each carrier's system was not compatible. To achieve the maximum benefit from the technology it is necessary to have compatibility between transportation modes as well.

There are numerous examples of successful equipment standardization in the container industry. A fundamental requirement for standardization of automatic identification equipment in the transportation industry is the development of hardware standards and tag data operational requirements. This advance can occur only after management has thoroughly proven the technology in the marine environment. Since 1984, U.S.-flag carriers have been evaluating the reliability and economics of automatic equipment identification through several prototypes being developed by the Cargo Handling Cooperative Program (CHCP), a U.S.-flag cooperative R&D group.

Once the marine operator knows *what* container equipment is available through the use of automatic identification systems, he must then be told precisely *where* that equipment is located in the terminal. Several technologies, available in manufacturing, are being evaluated for their application to location sensing in a

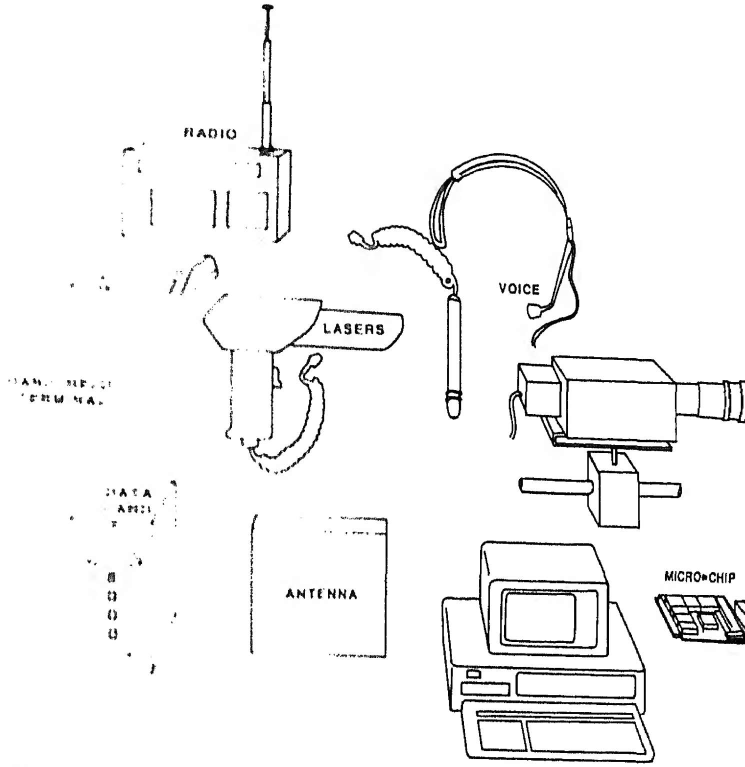

FIGURE 3 Source data automation technologies.

marine terminal. These systems would marry the identification the equipment with the location. Such technologies include:

- *Radar*—employing radio waves to detect location and mo ment,
- *Satellite systems*—such as Geo-Star where the satellites p vide a key location coordinate to a ground-based station t analyzes the location data;
- *Infrared triangulation*—where three infrared beams tr particular coordinates of a piece of equipment; and
- *Talking stones*—microcircuit based, grid-monitored syste

If any of the location-sensing systems prove economically operationally viable, computer-controlled stacking systems then become a reality. Logistics control and priority requ ments could ultimately be monitored by optimization algorith

programmed into the systems. This technology integrated with a reliable automatic equipment identification system would produce a level of terminal efficiency unmatched by an individual system approach.

U.S. terminals have only recently begun to evaluate the potential benefits of advanced information technology. One example is the hand-held computer system currently under evaluation in Savannah, Georgia. Yard inventories, previously recorded on the back of an envelope, today are being conducted with wireless data transmission systems. Longshoremen are using portable computers to conduct inventories and validate ship load and discharge. Equipment identification numbers are transmitted in real time to the carrier's host computer. Through this approach, keypunch and verification costs are eliminated and real-time, accurate data are instantly available to the operator. At a cost of approximately $80,000, a 200-acre facility can be outfitted with hand-held terminals to support gate, yard, and apron operations. Software costs are minimal. Only the interface software between the hand-held system and the operators terminal control system needs to be developed. Through the employment of this proven information technology, carriers need not be plagued with ship delays caused by misplaced cargo.

These types of systems are also prevalent in European and Asian ports. Hamburg Hafen und Lagerhaus instituted a wireless data transmission program last year to provide online communications between 47 terminal straddle carriers and terminal management. Bremer Lagerhaus Gesellschaft is also evaluating the introduction of this technology.* HHLA is planning to extend the system into its stacking crane and forklift truck fleet. Europe Container Terminus uses a wireless infrared data transmission system to send container information from its central computer to straddle carriers.

TRAINING TECHNOLOGY

This paper has addressed the volume of transactions that need to be managed in a container yard and technology that shows promise of being able to control that inventory. The diverse

* Efficiency drive. Cargo Systems (June 1985).

labor component in marine terminals demands fully integrated information systems to employ this technology effectively.

When a ship is in port, there are several work groups operating in the terminal, each performing its own function, sometimes independently, or sometimes in loose concert with other work groups. For instance, a trucker, following his own schedule, may appear at the terminal to deliver or pick up a specific container. Concurrently one longshoreman group may be performing a yard inventory while another gang works independently servicing a ship. In each group, it is through the marine clerk that all of these transactions are being conveyed. Under the overall guidance of the terminal manager, the clerks must provide information for spotting cargo and instructing equipment operators over a wide expanse of area in a constantly changing environment. There is very little consistency of skill between marine clerks. Without an adhered-to systems approach, there is no assurance that appropriate and accurate data are being collected.

In the 1980s marine transportation involves much more than the activities encompassed by the boundary of a terminal. Intermodal operations are accounting for a significant amount of U.S.-flag carriers' revenue. With this expansion goes an increased information flow, expansion of the work and influence of a marine clerk, and potential for a proliferation of inaccurate data. Although systems such as sophisticated container cranes and yard-handling equipment have improved the productivity of longshore work significantly, no major systems have been developed to improve the efficiency of marine clerks. It is this very function that is in most need of technological innovation. As Figure 4 illustrates, longshore productivity over the past decade has increased at a much more rapid pace than marine clerk productivity. Because of the operational intelligence handled by these clerks, technological improvements in this area will greatly increase productivity for the terminal operation as a whole.

Training aids are available to address marine clerk productivity. State-of-the-art data processing technology exists to provide the clerks with timely information and job performance tools that can be inexpensively developed. One example is the use of hand-held computer terminals for container inspection. Prompts can be given to the clerk to direct him to perform a thorough equipment inspection. Through the use of bar-coding labeling, the clerk need

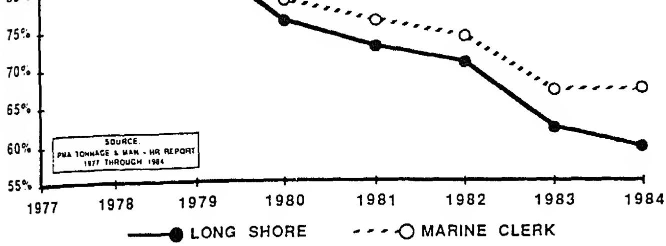

FIGURE 4 Change in man-hours/ton (relative to 1977) on the West Coast.

only enter a minimum amount of data. Under such a scenario the inspection/custody information scanned from bar codes would go directly from the hand-held terminal to the mainframe computer, allowing terminal management to access inspection and custody information minutes after the equipment has entered the yard. The result—more efficient and timely handling of data, faster throughput at the gate, elimination of containers used for the storage of interchange documentation, and of utmost importance, an accurate data base on which management can rely.

In recent years, American industry has begun to realize the full benefits of proper training. Training technology for the more skilled jobs has repayed its investment in reduced accidents and greater productivity. This technology has direct application tc the marine industry. In a recent study of U.S. marine trainir 214 longshore and clerk courses were identified. Most courses repetitive classroom training with extensive on-the-job exerc Simple audiovisual aids are available for most courses, but t is limited use of sophisticated structured tools or any typ motivational training.

As a whole, the maritime industry invests substantial amc of resources in training. The exact amount of that invest not be easily determined because a wide variety of or

such as the operating and stevedoring companies, unions, and maritime associations, are all involved in the process. Additionally, many of the costs of training are accounted for in on-the-job training, lost productivity, and damage as a man learns to operate a piece of equipment, and are not easily visible as training costs.*

All marine terminal personnel receive some training during their career. On the East Coast, the training is carried out primarily on the job, except for the crane-rated equipment training that is conducted by the operators and port authorities. On the West Coast, the Pacific Maritime Association (PMA) has the responsibility for the training of the equipment operators and clerks. However, despite PMA's $5 million budget for formal training there is still a healthy component of on-the-job training on the West Coast.

Computer-aided instruction, motivational training, video disc simulation, electronic blackboard, and multimedia presentations are used successfully in other industrial environments. They also have direct application to the marine industry, but they are not being employed here. For example, there are 23 crane operator training courses in the United States; none have available to them a crane simulator. Video technology now makes equipment simulators affordable. The most efficient use of training dollars would dictate the use of tools such as simulators before a company places an inexperienced operator in control of a piece of multimillion dollar equipment.

MATERIAL-HANDLING SYSTEMS

In a recently completed study of West Coast crane operations, documented observations show considerable potential for improved technology in crane activities. Some improvements relate back to better yard operations, but other improvements can be gained by applying proven technology to the crane. In most cases it is information that is needed. For example, the study has

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* Inventory of Maritime Training, unpublished report of the Cargo Handling Cooperative Program, U.S. Maritime Administration, Washington, D.C., November 1985.

shown that the crane travel times to the two closest ship positions are greater than to the more distant positions.*

In most cases these delays are caused by lack of information. The operator must have available to him real-time data in order to answer the following questions:

- Has the box safely passed over the ship rail?
- Is the load clear of obstructions?
- Can the crane increase speed or reduce the arc safely?

There are systems currently used in manufacturing that can address these problems. For instance, the speed, arcing, and positioning movements of the crane could be microcomputer assisted. Many industries economically employ microprocessor pick-and-place systems along with visual assist systems for the operator.

Current crane operations frequently require the operator to sight all movements from a difficult vantage point. Not only may the operator's visual perception be a potential cause for delay and accident, but the physical position of the operator may cause excessive fatigue. Ergonomic engineering has produced vision technology that would allow the operator to sight his processes from a more advantageous perspective while maintaining a more natural posture. Laser-based technology exists that would indicate to the operator when he is clear of obstacles during the traverse actions.

In the study previously mentioned, hostler positioning under the crane was also evaluated. The study revealed that two factors account for the majority of delays in this area. First, the crane operator frequently lacks a waiting positioned hostler. The crane operator is thus less likely to use maximum crane speed, and therefore crane productivity declines. Second, there are significant delays associated with locating the hostler in the precise position under the crane. Laser-positioning devices such as those used in manufacturing may be inexpensively employed to assist the hostler driver in properly positioning the hostler.

All of these systems may someday service a high-rise container storage facility. The feasibility of high-rise storage for marine containers is under analysis by most large terminals. At this time,

* Crane Cycle Improvement Study, unpublished report of the Cargo Handling Cooperative Program, U.S. Maritime Administration, Washington, D.C., November 1985.

the extremely high first-cost and unresolved technical issues as heavy loads and various new handling equipment, still out the benefits of random access and potential for reduction in and damage costs.

DECISION SUPPORT SYSTEMS

A major mistake made in introducing new technology tendency to develop "islands of automation"; for example, ing improvements in ship loading and discharge systems w thoroughly analyzing the impact these systems will have o or yard operations. Quantitative decision-support models solutions are arrived at mathematically can provide the sens analyses required to generate appropriate marine terminal s decisions. These models are now being employed in the ma industry. Management in this industry can validate its expe and good judgment through the use of computer decision-su models. Proper use of these models will ensure that th rine operator will not create productivity enhancing syste one module of a terminal while detracting from producti another module.

The CHCP is developing several simulation models f U.S.-flag carriers. Last year the CHCP developed a co terminal simulation model designed to assist carriers in long planning for major terminal acquisitioning projects. A day- operations evaluation model is currently under developmen

CONCLUSION

In order for the maritime industry to receive the ma benefit from advanced information technology the indust be required to develop compatible data networks and dat management systems. Once these networks are in place, mission of, for example, container location information fr operator's terminal to the next or from one mode to th will be fast and efficient. Advances in information system ever, will not relieve management of its broader responsib support new and innovative technology. Regardless of the of automation that exists, management must still motiva

train personnel, and must control operations. As technology advances, the challenges in these areas will become even greater, but the tools available through this advancement will change the direction of container terminal operations as drastically as the container itself did.

The Human Element in Marine Terminal Productivity

MICHAEL GAFFNEY and JOEL FADEM

The subject of productivity has received considerable national attention in recent years, even in the popular press. It could not have been lost on even the most casual observer that the rate of U.S. productivity growth has substantially slowed and is considerably out of line in comparison to the most progressive European and Asian nations, particularly Japan.

Even more immediate has been the awareness of loss of American manufacturing jobs and profits to higher-quality, lower-priced imports. This fact has certainly not escaped the attention of American port interests that have both welcomed the surge of imports and worried about the lack of exports—especially the West Coast marine terminal industry, which has the good fortune to be situated at one edge of the ocean that separates the manufacturing citadel of the Far East from the world's principal consumers.

What may not be so obvious, however, is the manner in which industrial organizations worldwide are attempting to mobilize their human resources to prosper (or just survive) in difficult economic times. These efforts have entailed deliberate (and sometimes radical) departures from business as ususal. The broad flavor of this shift in human resource strategy is contained in such

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Joel Fadem is with the Institute of Industrial Relations, University of California, Los Angeles. He has an international background of research into longshoring and in assisting joint union-management productivity improvement efforts.

phrases as "the new industrial relations" and "Japanese management style." What is referred to is an organizational structure and climate that provides for expanded use of the technical and problem-solving skills of employees at all levels.

This paper highlights the main components of this new approach to human resource management and considers their application to the U.S. marine terminal industry. To accomplish this it will be helpful to review what is taking place in other countries and in other industries.

First, it is important to clear up some confusion regarding the term "productivity." Productivity is frequently measured as a ratio of labor input to product/service output. That's fine as one gauge of productivity, but the term is sometimes interpreted too literally as a measure of the contribution of labor (how hard employees are working). That isn't always the case. For example, the ratio may show an increase or decrease in productivity due exclusively to the contribution, or failure, of machinery or systems.

Therefore, although productivity (of labor) is one measure of economic health, the true bottom-line indicator of industrial performance is one that measures trends in the financial rewards provided to owners, management, and labor. Factored into this financial equation is the matter of safety, which has nonfinancial value as well, but directly affects the bottom line of this industry in the form of substantial insurance premiums. Therefore, the authors' purpose is to illustrate how human resource innovation might improve the total output/input ratio.

WHY CHANGE?

Competition

Although American ports are generally not in competition with foreign ports, they are clearly in competition with one another—and the competition is getting stiff.

Competition between the West Coast and East/Gulf Coasts is increasing, fueled largely by the success of minibridge (especially with the introduction of double-stack trains). Within coasts, interport competition is also becoming more heated, especially on the harder-pressed East and Gulf Coasts where multiemployer bargaining appears to be on the wane. Stevedores under contract with traditional longshore unions more frequently find themselves

competing with firms employing alternative union labor or unrepresented labor. Indeed, as intermodalism redefines the meaning of the term "port," the marine terminal industry itself is facing growing competition from alternative union or nonunion container freight stations situated well inland.

In sum, intermodalism and deregulation appear to be breaking down earlier geographical and regulatory-based barriers to competition. Containerized cargo can now move to most locations at a competitive cost.

Safety

Safety has always been a concern in the marine terminal industry, but has recently become a more significant issue due to several deaths in Southern California. Perhaps the situation there is somewhat unique given the rate of expansion and consequent degree of reliance upon casuals, but it may also reflect what is taking place elsewhere in the industry. It appears that traditional work rules, training, and safety practices may not be adequate given the altered nature of work on the docks today. The question is, does the solution lie in the development and enforcement of additional rules by safety experts? Or does it lie in providing the employees themselves with an opportunity to investigate and analyze the safety problem, and to recommend appropriate solutions to a joint labor-management committee—solutions that may entail the development of a new or revitalized work organization in which employees take on more responsibility and authority to ensure their safety?

DIRECTION OF CHANGE

Work Force Reduction

Reduction in the labor content of products and services has been, and continues to be, a fact of life. This is true both for industries that face competition from low-labor-cost nations (shipping, shipbuilding) and for industries that are not in international competition, but are undergoing significant technological change. In the marine terminal industry, refinement of cargo-handling and information systems technologies has cut into the size of both the blue and the white collar terminal work force. In industrialized

nations, longshore employment has been halved in the past 2 decades in spite of a fourfold increase in tonnage handled.

Given the likelihood that the size of the work force in these industries will continue to diminish, two issues are raised:

1. How can this reduction be managed so as to ameliorate the effect on the existing work force and its organizations (unions)?
2. How can work be redesigned to maximize the effectiveness and safety of a smaller work force?

The first issue, that of softening the blow to existing workers and their organizations, is a humanitarian concern. With few exceptions, individuals and their organizations have survival as a first priority. It is unrealistic to expect anything but strong resistance to activities that threaten their continued livelihood and existence.

Especially in those industries in which labor is organized within powerful unions, employment (or at least income) security guarantees have been negotiated. The marine terminal industry is a very early and dramatic example. Reductions have been accomplished through a combination of attrition, work sharing, and income guarantees for existing workers.

The second issue—how to redesign work and work organization to correspond to a smaller work force—is one that is sometimes given short shrift within those same industries that have powerful unions. There are several contributing reasons:

1. Union attention is concentrated on the first issue, which is of greater importance to them—preservation and equitable sharing of jobs and income for their members.
2. Some hiring rules and work rules, designed to preserve and share jobs, are in apparent conflict with the objective of increasing the efficiency and safety of remaining workers.
3. Management is primarily concerned with maintaining the head-count reduction and is not inclined to risk that easily quantified cost savings in an effort to achieve less quantifiable productivity improvements through adjustment of the organization of work.

that is certainly the case in the marine terminal industry).

Larger Japanese firms achieve employment stability by means of a core group of employees hired for life, supplemented in labor demand peaks by subcontract labor. British shipyards are now guaranteeing the wages of their employees, and are assigning the workers to stable membership production teams. European shipyards are also hiring core employees with employment guarantees honored during periods of shipbuilding downturn by contracting out these workers to other steel-fabricating companies. Throughout the shipbuilding world, employees are no longer being casually assigned work within yards. More commonly, they are assigned to fairly stable teams that work in the same general area of a yard on specific construction modules.

Seamen around the world (licensed and unlicensed) are now being hired by individual firms on a contractual basis and are assigned to individual ships for time durations of several years. It is reported that Saturn workers will have lifetime employment guarantees; currently autoworkers have achieved 3-year job security.

In longshore work, the issue of industry-wide employment stability has a long history. Dock workers in Britain are registered under a National Dock Labour Scheme and are guaranteed a weekly 40-hour minimum wage. A similar scheme is in effect in Australia.

In the United States, collective bargaining has provided the means by which longshore employment has been stabilized and regulated. For many years on the East and Gulf Coasts, International Longshoreman's Association (ILA) members have worked under full-year minimum payment guarantees that provide up to 2,080 hours of straight-time compensation. On the West Coast, class A longshoremen also benefit from substantial income security protection, with employer assignment made through the union hiring hall.

Employment stability within stevedore firms is less common. British dock workers are a notable exception in that they are assigned to port employers on a permanent basis. When redundant workers cannot be transferred to other port employers, they are assigned to a temporary unattached register (labor pool) and paid a lesser weekly amount by the National Dock Labour Board. Australian waterside workers have less continuity in that they are assigned to employers on a weekly basis by the Australian National Stevedoring Industry Authority.

In the United States, even less within-firm continuity is achieved due to the operation of rotary hiring halls, although permanent assignment was a de facto reality for certain specially trained longshoremen in the early days of containerization. The expansion of container traffic and specialized gear has suggested the need for greater continuity of dock worker assignment. The "steady man" issue has haunted West Coast labor relations since its original acknowledgment in the 1960 Mechanization and Modernization Agreement.

Employers cite the expansion of container traffic and specialized equipment and the need for more steady assignment of dock workers. They wish to increase their use of capital through the services of a reliable skilled manpower base. In contrast, union officials—whether they are the ILA, the International Longshoremen's and Warehousemen's Union (ILWU), Transport and General Workers Union (Great Britain), or Waterside Workers Federation (Australia)—remember the abuses of favoritism in hiring, and preserve the hiring hall to achieve equity, homogeneity, and solidarity among its members.

American seafaring union leaders have similar memories of hiring abuse, but are holding to their rotary shipping hall system for an additional reason. Unlike the longshore industry, they have not stabilized the seagoing work force, and employ the hiring hall to spread available work among a too-numerous membership.

As effective as the hiring hall may be in spreading employment opportunities, it has its shortcomings. Terminal operators are less willing to make training investments in short-term employees. Short-term employees are less likly to become familiar with specific pieces of machinery, company operating practices, or even the work habits of fellow workers. It is difficult to form a cohesive team when the faces are continually changing.

Employee Involvement in Problem Solving

In traditional industrial organizations, very few employees are hired to solve problems. Those few are generally referred to as "management," or in many instances, as "top management." The dramatic quality and productivity accomplishments of the Japanese brought home to the United States the fact that all employees, not just managers, have problem-solving capability—especially regarding their immediate work responsibilities.

A number of American industries have, in the last 5 years, developed new organizational structures to encourage employee problem solving at all levels. Known variously as "quality circles," "labor-management participation teams" (steel), or "employee involvement teams" (auto), these problem-solving groups are formed of 8 to 12 hourly and management employees that work an hour or two per week, occasionally full time, on detailed data collection and analysis related to problems that they have identified themselves or that have been recommended to them by management or a joint labor-management committee. Recommendations proceeding from these groups are given careful consideration by high levels of management and union, and the process itself is sanctioned and monitored in unionized settings by joint labor-management committees.

Problem-solving teams of this nature generally deal with noncontractual issues relating to productivity, quality, and safety. Given the significance of safety to the marine terminal industry, it is instructive to note the accomplishments of employee involvement in the Japanese shipbuilding industry.

The Japanese have been very frank in admitting that the productivity of their shipyards during the tanker-factory era of the mid-1960s was built "on the backs of the workers." One fallout of this speedup was an unusually steep rise in the frequency and severity of accidents. These shipyard safety statistics were so out of line with the record of other Japanese industries that the government established special teams to enforce safety regulations in shipyards. This group was empowered to arrive at a yard unannounced and shut down production if they found any violations at all.

At this same time, Japan was in the process of spreading their new human resource innovation, quality circles, throughout a number of industries. The shipyards, faced with their safety

problem and close government enforcement, chose to put the initial quality circles to work, not on efficiency or quality issue but on the matter of safety.

The result was a phenomenal improvement in yard safety. I way of international comparison, there were, in 1980, less lo time accidents in all of the Japanese shipyards combined tha in one single American yard—and the Japanese produced times the U.S. tonnage in that year. Japanese shipbuilders gi full credit for this accomplishment to the activities of shopflo quality circles.

If there are any employee involvement activities under wa within the marine terminal industry, they have not been publ cized. It is likely that there are few, if any, given the constant changing composition of the work force within firms. Problen solving teams require time "off their tools" to do this sort of wo (paid for by management), and a long enough period of assoc ation to collect and analyze data—opportunities that do not well in an environment of temporary work assignment.

Decentralization

Just as corporations are more frequently setting up their d visions as semiautonomous profit centers, so too are functio within firms becoming less centralized and more integrated in the primary business of the enterprise. The underlying logic that employees are often the best qualified to make decisions their immediate sphere of work, and that organizational burea cracies (layers of supervision and staff) not only extract a cost terms of higher overhead, but also prevent, rather than facilitat the productivity of the employees they are supposed to help.

Many ship operators are reorganizing their shoreside operatio in a manner that gives primary decision-making responsibility a group of senior officers aboard each ship. These shipboar management teams, in turn, are supported by a single point contact with the shoreside office, a multifunction ship manag or line manager. And to make adjustment for the increase management content of the jobs of ship officers, much of t planning and daily decision-making related to the maintenan of these vessels now rests in the hands of the unlicensed wo force. This is quite different from the traditional structure

ship operation in which shoreside functional specialists, such as marine superintendents and port engineers, closely directed the shipboard officers within their respective disciplines, who, in turn, directed the unlicensed in their separate departments.

Similar changes are under way in shipbuilding. Engineering, planning, and scheduling functions are being pushed down from main administration into the production workshops. Within production, the hourly work force is more likely to be formed into small teams with responsibility for meeting a schedule within budget, and with the authority to make decisions that will permit them to be successful. Previously, hourly workers were reassigned as individuals to various jobs within the yard on a day-to-day basis, with minimal responsibility and no authority.

In the marine terminal industry, it appears that the trend may be in the opposite direction. In the days of break-bulk operation, longshoremen usually worked in the context of fairly self-managing work groups (gangs). In the age of containerization and mechanization, although the term "gang" may have survived, longshoremen work in more isolated fashion (men in cranes, driving straddle lift carriers, and lashers working 20 to 40 feet apart atop the boxes), and have less control over their work. Even the role of first-line supervisor, the "walking boss," has been diminished, as detailed directions are now more likely to come from terminal superintendents. Part of the safety problem may be related to the distintegration of the traditional gang system.

The argument might be made that intermodalism and information systems require more centralized (rather than decentralized) control in marine terminal operation. The same argument has been used in the defense of centralized control of engineering, planning, and scheduling within zone construction shipyards (which is the construction equivalent of intermodalism), and in the defense of centralized control of ship management (also a link in intermodal systems).

Experience indicates, however, that the best use of information system advances is in the facilitation of communication between self-managing activities. The facts demonstrate that interim-product modules fit together on the ways best in those shipyards that have made engineering, planning, and scheduling functions the responsibility of individual production workshops, and that ship operators who support but do not direct the activities of

shipboard management teams aboard individual vessels, achiev substantial cost savings.

Just because large intermodal firms are replacing smaller stev doring companies does not mean that they have to operate a monolithic bureaucracies. In fact, one of the advantages of so phisticated information systems is that they allow elements o large organizations to be more self-managing, because they hav access to a much wider range of information (they can see the "b picture"), and because they do not have to wait for informatio to be routed to them.

Multiskilling

Providing workers with a greater range of skills, and the o portunity to use them, is a clear trend in a number of industri today. In some instances, this multiskilling can be seen as a nece sary adjunct of work force reduction (fewer people accomplishi the same range of tasks). This is certainly the primary stimul for the creation of general purpose (dual purpose or multipurpos seamen and semi-integrated officers aboard merchant vessels.

Multiskilling also permits a greater degree of employment a work group stability, such as in shipbuilding, where workers longer have to be moved in and out of the yard, or work area with every change in the stage of construction.

The practice has also been introduced for the purpose of i proving job satisfaction of workers through provision of a varie of tasks (especially in assembly-line production operations).

Frequently, multiskilling is accompanied by additional compe sation schemes that reward employees for the greater range skills they possess. In some instances this takes the form of premium rate for a single multipurpose job classification (ge eral purpose seamen). In other cases, a sliding scale is provid that corresponds to any number of skill combinations. Individua working under these "pay for knowledge" schemes are reimburs at a rate reflecting their range of knowledge or skills, regardle of the capacity they may be working in at any particular point time.

For the marine terminal industry, multiskilling may be of val for its contribution to the composition of smaller sized gan

or simply in providing the appropriate skills when needed. Under current arrangements there is frequently a mismatch between skills and requirements, due, in part, to narrow job specializations and on-and-off multiemployer training schemes. It should be emphasized that where multiskilling arrangements have been instituted without additional training for employees (who are multiskilled in name only), results have been disappointing—in terms of productivity, quality, and safety.

Incentive

It is possible to achieve a highly productive work force through intrinsic rewards alone (job satisfaction, pride, and dignity) that often accompany the introduction of the sort of human resources innovations that have been described. Eventually, these productivity gains are translated into extrinsic rewards (improved employee financial gains) through negotiated wage improvements.

A more powerful incentive arrangement is one in which the efforts of the work force translate more directly and immediately into financial rewards. Putting aside individual incentive systems (piece-rate) that have been tried for years and are now fading in almost all industries (even in apparel), these more immediate extrinsic incentives fall into two main categories: profit sharing and gainsharing.

Profit sharing is a concept that is familiar to most. Employees share in an established portion of any profits generated by their firm. This financial reward is a bit more immediate and direct than periodic wage and salary increases, but its shortcoming lies in the fact that a firm's profit does not necessarily reflect productivity gains achieved through the efforts of the work force. Profit in any period can be exaggerated due to sale of assets, or can be minimized through capital acquisitions or other conversions of funds. For an incentive system to work well, it should directly reflect the productivity of the work force, not the internal financial manipulations of the firm.

Gainsharing, like profit sharing, is a group incentive arrangement, but one in which concrete productivity gains, not illusory profits, are shared between shareholders and labor. There are several variations on the gainsharing theme, but they share a common thread. A productivity base is established, usually through

historical or engineered time standards. Any improvement in p
ductivity over this base is shared between employees (salaried
hourly) and shareholders. Payout is frequent (monthly). G
sharing arrangements are frequently associated with empl
involvement structures that allow workers to offer suggestions
make decisions) that permit them to achieve productivity gai

Although gainsharing is found primarily in manufacturing
tings in which productivity is fairly easily measured, it is
being tried in a U.S. shipyard environment in which producti
standards are very difficult to establish. Kaiser Steel Fabrica
and the Boilermakers have entered into an agreement in w
both parties jointly work up each bid for the constructio
offshore oil platforms. In this depressed market, and in di
competition with low labor cost Asian nations, the company
union have agreed to bid these jobs at a labor rate substant
less than that agreed-to in their 3-year labor agreement. Wh
contract is won, and if a platform is built for less hours than
100 percent of this gain goes directly to the work force until
are made whole with the 3-year agreement. If further producti
gains are made, additional gains are split 50/50 between the w
force and the company. The lesson of the Kaiser/Boilerma
case is that a gainsharing base can consist of an agreed-u
bid, rather than an historical or engineered time product
standard.

The authors know of no gainsharing application within
marine terminal industry, but it can certainly be tried whe
productivity and safety baseline or bid baseline can be establis
What would complicate a gainsharing scheme in this industry
least for longshoremen) is the lack of employment stability w
firms.

Another organizational innovation related to incentive is
of the employee-owned firm. Although found overseas (Swe
seafarers have been pooling their resources to purchase
sels from their now-bankrupt former employers), employee-ow
firms have largely been an American phenomena, due in pa
U.S. legislation that provides very favorable tax advantage
participating banks. Since deregulation, a number of truc
firms have made use of employee stock ownership plans (ESO
to remain in business. However, formal employee ownership
not automatically guarantee a structure of management style

have no greater role in decision making than prior to the buy-out. The most successful employee buy-outs have incorporated a high degree of employee involvement.

Some firms are now sharing with their employees gains achieved through savings in health and safety costs. Although health care gains are commonly distributed through an individual incentive arrangement (appropriate since health costs are frequently the result of individual life-style), a group incentive arrangement does make sense for safety-related savings, as safety is not strictly a matter of individual behavior.

Labor-Management Cooperation

There are certainly issues over which labor and management should, and will, continue to interact on an adversarial basis. These are issues in which one side's immediate gain is necessarily the other's immediate loss. The overall size of the economic package is an example.

However, there are many other workplace issues that do not constitute such a zero-sum exchange—those in which both parties may gain. The operation of employee involvement groups is a case in point. It is in this arena that labor-management cooperation is proving to be of value in other industries.

Labor-management cooperation in the United States generally takes the form of parallel structures of labor-management committees, from the highest levels of management and union leadership down to joint shopfloor activities.

The value of this form of cooperation lies in the fact that it provides an opportunity for both sides to think through jointly, and experiment with, new and unfamiliar structures of work. Rather than rushing to judgment with collective-bargaining positions, labor and management (and their members/employees), through these joint committees, are first able to gather some data and gain experience.

All of the innovations mentioned in this discussion are rooted in collective bargaining. But many of them have been stimulated and fleshed-out by means of various structures of labor-management

cooperation ranging from union representation on boards
rectors to quality circles.

RECOMMENDATIONS

The recommendation of the authors is for the marine te industry to attempt, through collective bargaining and management cooperation, to increase the efficiency and sa its work force by developing, experimenting with, and impl ing new forms of work. The details of these new work stru will be determined in the process. However, it is likely th will include some of the following features:

- greater use of the existing and potential technical s employees (multiskilling);
- greater use of the potential problem-solving skills of e ees (employee involvement teams)—these teams should pr be put to work initially on the safety issue;
- provision for sharing of efficiency and safety gains;
- return to more decentralized decision making (self-ma gangs); and
- greater stability of employment within firms and withi groups (in a manner that will not result in inequitable of work)—the hiring hall could still be used to make assi to more permanent positions in the larger firms that ca vide regular employment, to make more frequent assignm smaller firms that cannot maintain a regular work force, to reassignment in all cases, and to assign casuals.

PRODUCTIVITY AT SELECTED FOREIGN MARINE TERMINALS

Terminal Productivity at Europe Container Terminus, Rotterdam: A Variety of Factors

JOAN RIJSENBRIJ

This paper highlights various factors that influence terminal productivity and provides representative data concerning the situation in a West European container terminal in 1985.

PRODUCTIVITY: WHAT IS THE PRODUCT?

Container terminals are the indispensable links between the various modes of transportation—ship, rail, road, and barge—and their function may be defined as follows: "A container terminal is an organization offering a total package of activities to handle and control the container flows from the vessel to road, rail, and waterways and vice versa, resulting in a maximum service for

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shipping and inland transportation against minimized costs.' other words, service to both sides of the interacting transporta chain is the sole product of the container terminal operator.

The product quality may be defined as handling-speed with requisite reliability and flexibility. Expressions such as "maxin service," "required service level," and "minimized costs" a least open to discussion.

However, one objective is clear: the required level of se and the resultant handling costs must never lead to restri transportation times or uneconomic total transportation c Transportation companies (shipping, trucking, and railroads) terminal operators must cooperate in achieving a maximum of capital and labor investments in transportation and han systems and organization regardless of peak demands, clashi vessels, stacking capacity limits, increasing labor restrictions other factors.

Some characteristics of the service product to be provided high throughput terminal may consist of:

- operating 7 days a week, 24 hours a day;
- providing a total vessel-handling operation within 24 h (from the moment the gangway lands to the moment the containers have been lashed);
- providing a standard service, even if a large number of call on the same day;
- providing adequate organization and handling system allow quay-side and shore operations to work simultaneously not closing the gate while working the vessel);
- having the ability to process road haulers through the minal within half an hour (average);
- having the ability to handle trains and barges at schedule-times within several hours;
- providing safe handling of containers from the point of of both men and cargo;
- having a 100 percent reliable real-time control system, for physical handling and information flow;
- providing the online presentation of data to allow pre ning and integration of subsequent transportation steps ar porting all relevant information to the lines agents; and
- providing back-up activities to maintain a smooth con transportation flow. These include container freight station (

reefer plants, empty container depots, trailer parking, container cleaning, and repair.

Analyzing the productivity of a terminal organization that may provide such a complex product mix of services is not simple. This is demonstrated by the variety of representative indicators that exist for the assessment of terminal productivity.

Some of these typical indicators are:

- number of moves per employee (including or excluding casual labor);
- number of moves per meter quay-wall;
- throughput in moves per acre (hectare);
- gross moves per gross (or net) crane hour;
- number of moves per crane per year;
- number of overall maintenance man-minutes per move;
- production hours per move;
- number of handlings per container moved through the terminal;
- number of processing minutes per container moved through the terminal;
- number of trucks handled at the gate per lane per hour; and
- processing time per road truck, train, or barge.

It is evident that no single specific indicator will represent "the" overall terminal productivity. There are, moreover, many factors that will influence the total terminal cost and therefore the resulting price for the service product(s) offered by a terminal operator. Table 1 gives a list of some of these influencing factors.

In order to investigate possibilities for improvement, a terminal should analyze a variety of characteristics describing the specific container flows and services. Some examples are given in Figures 1 to 7 (pp. 153-157). The following observations can be made:

- The distribution over the week from vessel arrivals and call sizes (Figure 1) is important for man-hour planning.
- The arrival pattern of road haulers at the gate (Figure 2) and the related period of time haulers spend at the terminal (gate-in/gate-out) shows the relation between peak-hours and increasing processing time at the terminal. A guaranteed maximum service time for road haulers throughout the day will require additional (possibly uneconomic) labor and equipment during limited periods

TABLE 1 Terminal Cost Influencing Factors

Approach channel characteristics	Truck arrival pattern at the gate
Subsoil	Cost of energy
Climatical conditions	Offered services during the week
Local construction cost level	Extra services like vessel stowage, planning, lashing
Scarcity of land	Modal split
Local labor cost	Financing
Type of labor contract	Quality of information exchange
Industrial relations	Activities for customs
Available casual labor	Possibilities for closing time
Vessel arrival pattern	Single or multi-user
Utilization rate of berth and cranes	Auxiliary services (e.g., dep[illegible] repair)
Dwell time of containers	
Gate opening hours	

of the day. However, a smoothly distributed arrival of road haul[illegible] is still an operator's dream.

• The modal split (Figure 3) is important to evaluate t[illegible] handling activities over the basic transportation modes (such [illegible] sea-going vessels, trains, barges, road-trucks, and CFS). Figur[illegible] shows how the activities may change under an equal producti[illegible] level at the quay-wall. So, the production output of a termin[illegible] which is often presented in moves (or TEUs) per year over t[illegible] quay-wall, cannot be the only assessment figure for productivit[illegible]

• The need for cranes is presented in Figures 5 and 6. Th[illegible] show the influence of single-use or multi-use operations, the lat[illegible] requiring more cranes in order to cope with service demands un[illegible] clashing conditions. This results in an unavoidable lower use [illegible] crane per year.

• The continuous monitoring of crane delays (Figure 7) [illegible] inform the operator about the nature of causes that result[illegible] nonproductive crane time. It will help to achieve improvement[illegible] hourly crane production.

• Shipping lines regularly record the production levels at [illegible] various terminals (ports), so that this information will be av[illegible] able for the terminal operators. The data concerning number[illegible]

loaded, empty, and shifted containers show that the comparison of plain gross moves per crane hour is not a very representative tool for comparison. Hence the handling of hatches and nonstandard cargo slows down crane production while, on the other hand, the shifting of containers is obviously a simple and speedy crane activity.

While these examples have demonstrated that the product of a terminal can be defined, they have also shown that different terminals will offer different products, dependent on the typical location and transportation characteristics. So, if productivity comparison between terminals is required, then the product characteristics should be examined as well.

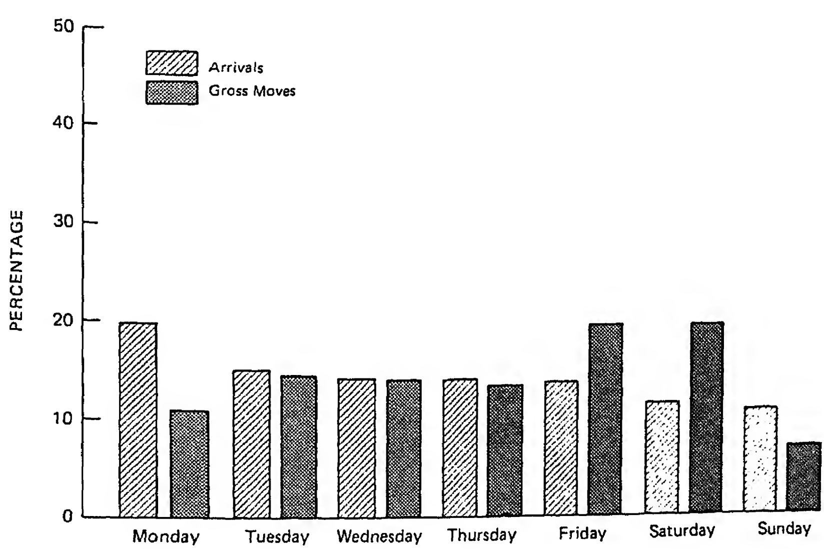

FIGURE 1 Weekly distribution of vessel arrivals and call sizes.

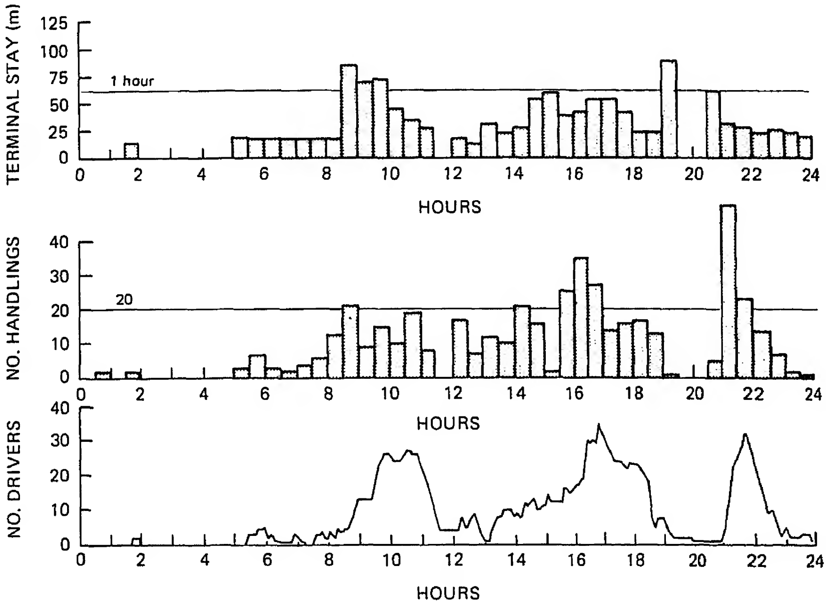

FIGURE 2 Daily arrival pattern and cycle time of road haulers.

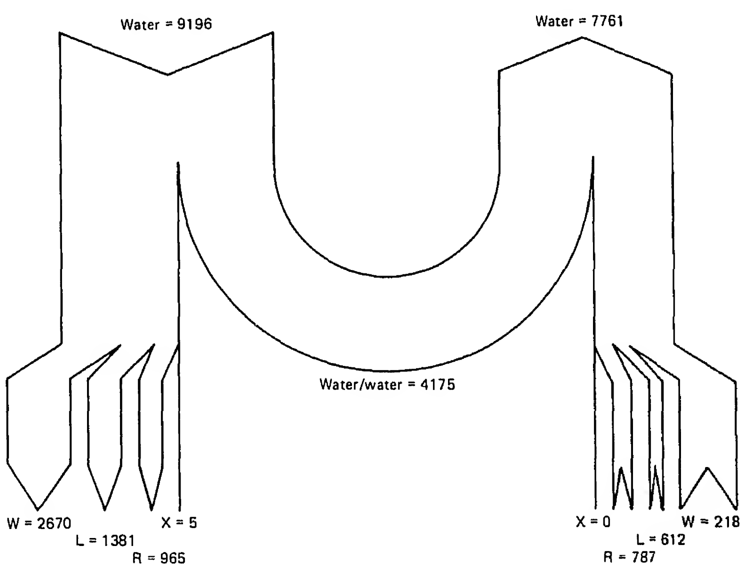

FIGURE 3 Monthly modal split of a multi-user terminal client.

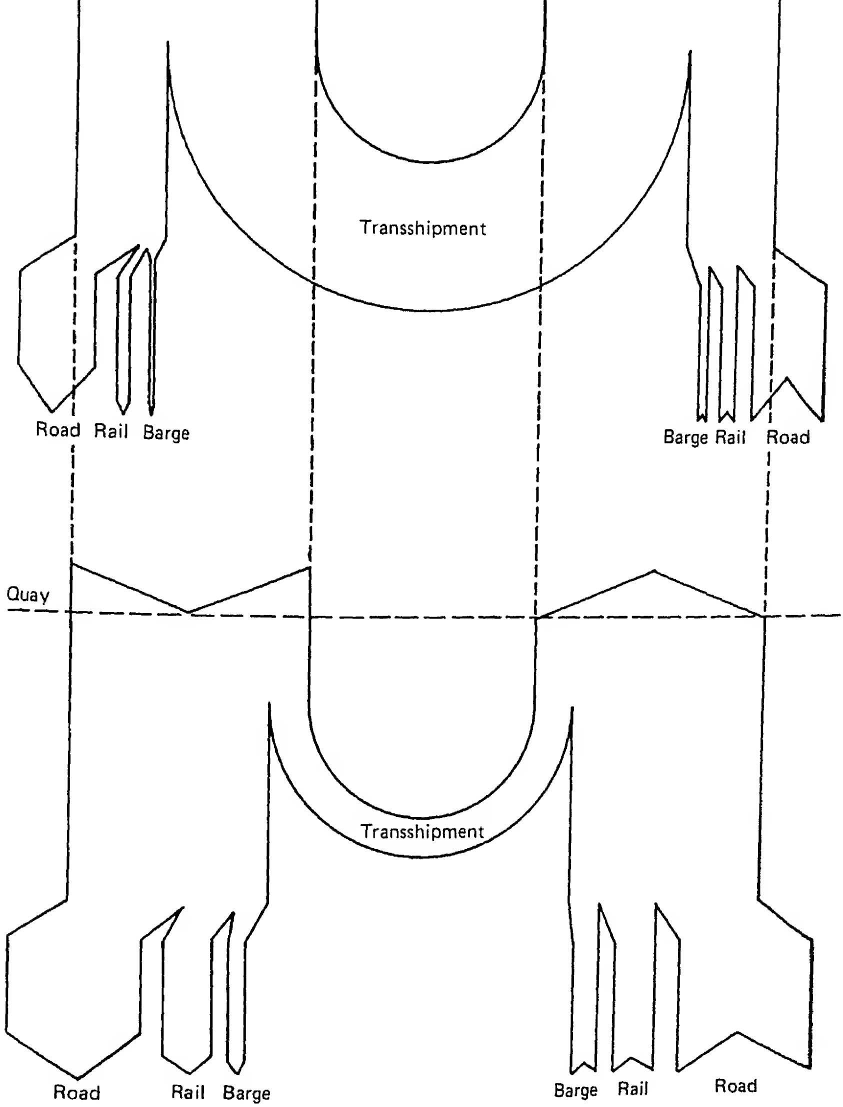

FIGURE 4 Influence of terminal utilization on modal split.

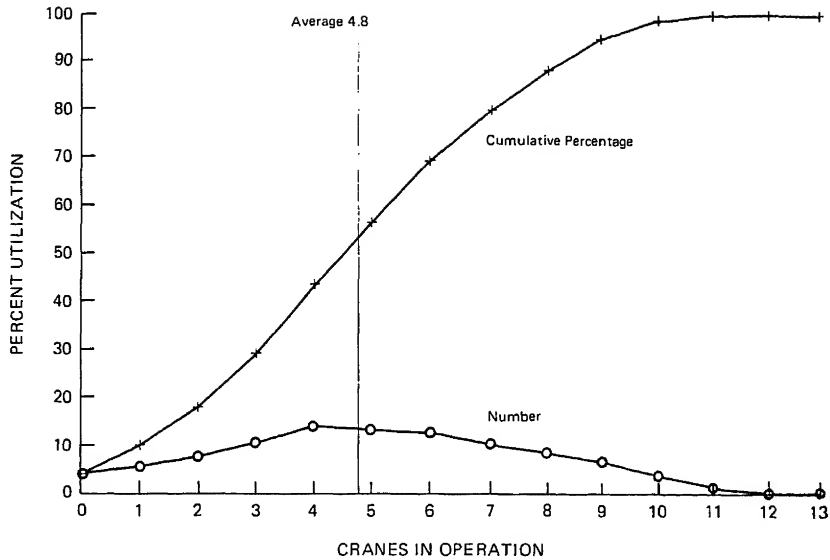

FIGURE 5 Crane utilization—multi-user terminal, 1984.

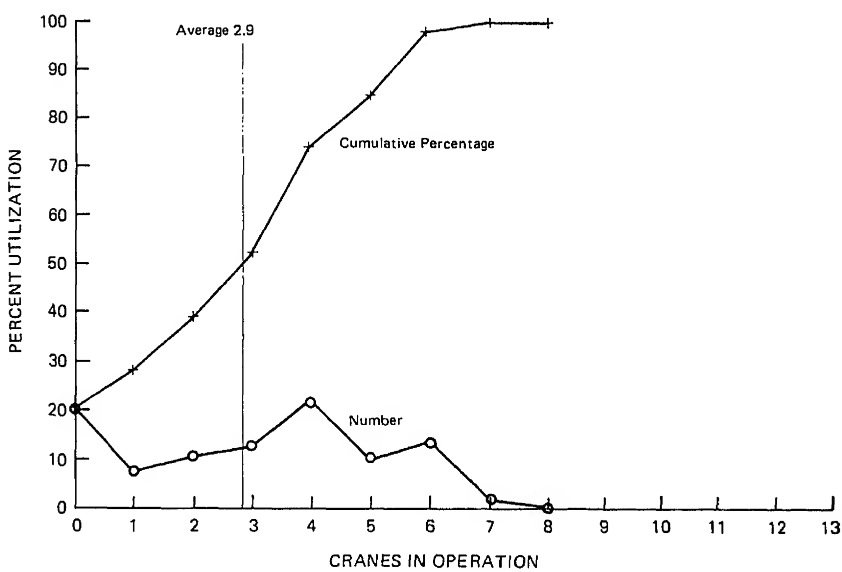

FIGURE 6 Crane utilization—single-user terminal, 1984.

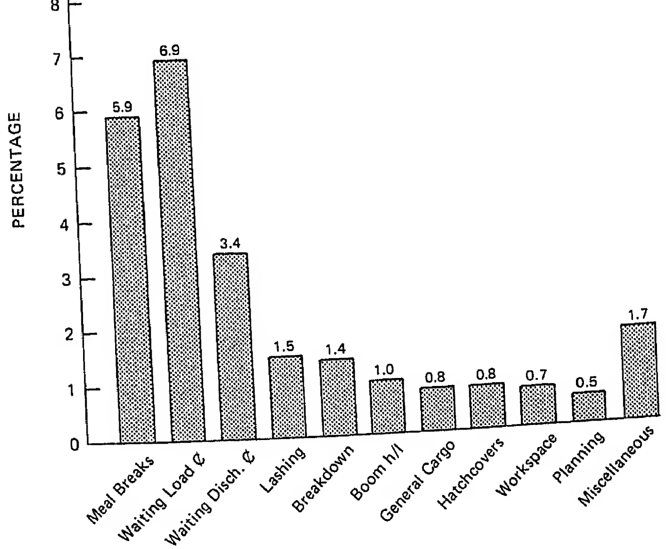

FIGURE 7 Causes of crane delays.

PRODUCTIVITY CONTROL

So far, the users of terminals are principally interested in crane production, which represents a major item of the terminal product. The total cost for the processing of a container through the terminal (= product price) is the other major element for a shipping line to assess its attractiveness.

The analysis of cost elements will be a continuing activity for any terminal management. Here are some examples from the West-European area:

- The review of all expense categories (see Table 2) will show management which areas should receive its attention if proper cost control is to be achieved. The costs for personnel and investments are the two dominant elements.
- As labor is by far the most expensive element in Western Europe, it is necessary to analyze where labor is employed. Table 3 characterizes the labor force of Europe Container Terminus (ECT).

TABLE 2 Expenses of "Imaginary" Profitable Terminals in Europe

Expense Category	Percentage of Total
Personnel	60
Depreciation	12.5
Financing	3
Maintenance (parts and services)	6
Lease (e.g., quay wall, buildings)	5.25
Energy	4
Insurance (including own risk)	2.25
Duties	1
Miscellaneous (e.g., telex, travel)	3
Profit (before tax)	3
Total	100

TABLE 3 Characterization of Europe Container Terminus Work Force

Category	Percentage of Total
Operations	70.8
In 5-shift system, 86.0%	
In 2-shift system, 9.5%	
In 1-shift system, 4.5%	
Maintenance	9.9
In 5-shift system, 36.0%	
In 2-shift system, 43.0%	
In 1-shift system, 21.0%	
Container control	4.5
Security	3.6
Management and other staff	3.1
Administration	2.9
Engineering, purchasing, services	2.7
Data processing	2.5
Total	100[a]

[a]Inclusion of casual labor in these figures would increase the total by 8.5 percent.

TABLE 4 Available Working Hours Per Laborer at the Europe Container Terminus

Man-hours according to labor contract	52 × 32.55 = 1,693 hrs.
Not available due to:	
Vacation 23 × 7.75	−178 hrs.
Illness (average 10%)	−169 hrs.
Holidays/special leave	−15 hrs.
Training	−39 hrs.
Subtotal	−401 hrs.
Available for operations	1,292 hrs.[a]
Shifts per year 1,292/7.75	= 167 shifts

[a]The yearly available effective working hours are influenced by non-productive periods and elongation of breaks, among other factors.

- The analysis of productive hours to be produced by labor is presented in Table 4. That data allow for cost calculations but also provide a basis for labor contract negotiations. It is clear that the overall industrial working conditions will influence the annual productivity. In Europe the trend over the last few years has been to diminish the amount of working hours per week, resulting in higher hourly labor cost.
- The productivity per crane per day can be produced through analyzing all causes of time periods in which the crane is unable to handle containers. Table 5 shows that effort is required to increase the time a crane can be made available for container-handling activities. The major areas of attention will be meal breaks and shifts, hatch-cover and other noncontainer handlings, and information exchange between the terminal and shipping lines or their representatives.

With respect to the control of productivity and handling costs, it is necessary to provide management with the appropriate tools. Figure 8 shows a general control cycle for terminal operations.

ECT has developed a control system to monitor every vessel operation; at the home terminal this is done by the checker beneath the crane who is responsible for recording all activities and delays. At the new Delta terminal all these data are processed online to

TABLE 5 Available Working Time for Cranes (minutes)

Factor Affecting Crane Availability	Present Situation	Potential for Productivity Improvement
Theoretical availability (24 × 60 minutes)	1,440	1,440
Official meal and coffee breaks	100	100
Standard allowed for break elongation and shift changes	55	55
Additional loss through unallowed elongations of meal breaks and shift changes	35	0
Technical breakdown	22	10
Crane assistance for lashing	36	30
Crane time for hatch cover handling and nonstandard situations	142	100
Crane delay as a result of inadequate information from shipping line	100	20
Total losses	490	315
Available for production	950	1,125

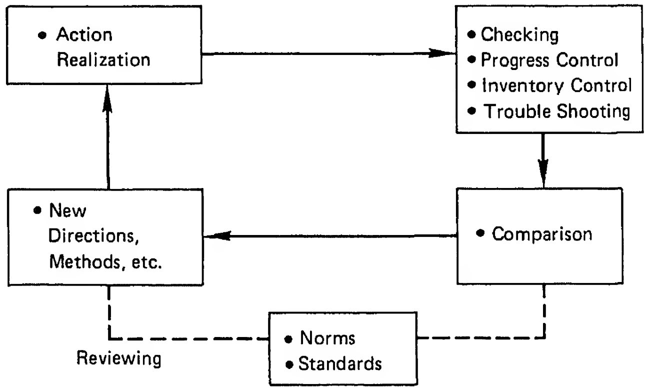

FIGURE 8 Control cycle for terminal operations.

are presented to terminal management and shipping lines to show conformance with their mutually agreed-upon production objectives.

In addition to the regular presentation of performance data, it is helpful to provide middle management with tools that allow them to control the quality of their daily decisions and management activities. An example of such a tool is given in Figure 10: a microcomputer-based crane assignment program that helps supervisors to select the optimum crane assignment for the volume to be handled on a vessel with a specific stowage plan. Additional information, e.g., man-hours used per move and truck or processing times, will also support daily decision making.

The projection of crane production objectives is another tool for productivity control. Table 6 (p. 165) shows objectives such as these for both a smaller and a larger terminal.

One point should be clearly stated: the improvement of hourly crane production will result in a lower use of cranes if the volume remains stable. This must result in increased equipment costs per hour that must be considered when making cost calculations. This element is important when planning for the installment of new technology with higher production capacity (e.g., second-trolley cranes). Table 7 (p. 165) shows a projection concerning crane use rates for the ECT Delta terminal. The figures show that a demand for more cranes, resulting from the simultaneous handling of mainline and feeder vessels, causes lower use per crane, so the improvement of one product characteristic (more handling capacity) leads conversely to a deterioration in another product characteristic (the handling price).

Line :			
Vessel :			

Waiting for berth :			0:00
Vessel berthed :	2-01-86		17:50
Vessel sailed :	3-01-86		3:20
Berth time		Hrs	9:30
Berth delay :			0:00

Ship's operation started :	2-01-86		17:50
Ship's operation finished :	3-01-86		2:42
Ship's time		Hrs	8:52

Gross crane hours	Hrs	15:54
	-	3:01
Net crane hours	Hrs	12:53

Total moves	351

Breakbulk (packages)	Colli	0

Performances	Moves per hour
Berth production	36.9
Ship's production	39.6
Gross crane production	22.1
Net crane production	27.2

Remarks: code 98 container not available.

FIGURE 9 Terminal performance report.

|| 24 Hrs ETA 2-01-86 19:00
|| 24 Hrs ETD 3-01-86 5:00

Gross crane hours	
Crane number	Gross hours
8	8:40
9	7:14
	+
Total	15:54

Delays due to ship	
Lashings	0:21
Meal - Breaks	1:00
See remarks	1:40
Total	3:01

Discharged	216
Loaded	109
Shifted	0
Hatches	26
Stacking frames	0
Non-standard	0 +
Total	351

Workplan 0.6 ect Rotterdam

Ship: Developer Datum: 850715

	01	02	03	04	05	06	07	7A	7B	08	09	10	BR	11	12	13
:00	.	.	.	4D3	.	3D3	.	.	2D4	.	.	.	.	.	1D2	.
:15	.	.	.	4D3	.	3D3	.	.	2D4	.	.	.	.	.	1D2	.
:30	.	.	.	4D2	.	3D2	.	.	2D3	.	.	.	.	.	1D1	.
:45	.	.	.	4D2	.	3D2	.	.	2D2	.	.	.	.	.	1D1	.
:00	.	.	.	4D1	.	3D1	.	.	2D2	.	1D3	.	.	.	.	.
:15	.	.	.	4D1	.	3D1	.	.	2D1	.	1D3	.	.	.	.	.
:30	.	.	.	4DS	.	3DS	.	.	2D1	.	1D2	.	.	.	.	.
:45	.	.	.	4DP	.	3DS	.	.	2DS	.	1D2	.	.	.	.	.
:00	.	.	.	4DP	.	3DP	.	.	2DS	.	1D1	.	.	.	.	.
:15	.	.	.	4LP	.	3DP	.	.	2DP	.	1DS	.	.	.	.	.
:30	.	.	.	4LS	.	3LP	.	.	2DP	.	1DS	.	.	.	.	.
:45	.	.	.	4LS	.	3LP	.	.	2DP	.	1DP	.	.	.	.	.
:00	.	.	.	4DC	.	3LP	.	.	2LP	.	1DP	.	.	.	.	.
:15																
:30																
:45																
:00	.	.	.	4DC	.	3LS	.	.	2LP	.	1DC	.	.	.	.	.
:15	.	.	.	4LC	.	3LS	.	.	2LP	.	1DC	.	.	.	.	.
:30	.	.	.	4LC	.	3DC	.	.	2LS	.	1DC	.	.	.	.	.
:45	.	.	.	4LC	.	3DC	.	.	2LS	.	.	1D3	.	.	.	.
:00	.	.	.	4L1	.	3LC	.	.	2LS	.	.	1D3	.	.	.	.
:15	.	.	.	4L2	.	3LC	.	.	2DC	.	.	1D2	.	.	.	.
:30	.	.	.	4L2	.	3LC	.	.	2DC	.	.	1D2	.	.	.	.
:45	.	.	.	4L3	.	3L1	.	.	2DC	.	.	1D1	.	.	.	.
:00	.	.	.	4L3	.	3L2	.	.	2DC	.	.	1D1	.	.	.	.
:15	.	.	.	4L4	.	3L2	.	.	.	2D3	.	1DS	.	.	.	.
:30	.	.	.	4L4	.	3L3	.	.	.	2D3	.	1DS	.	.	.	.
:45	.	.	.	4L4	.	3L3	.	.	.	2D2	.	1DP	.	.	.	.
:00	.	.	.	4L4	.	3L4	.	.	.	2D1	.	1DP	.	.	.	.
:15																
:30	.	.	4D4	.	.	3L4	.	.	.	2D1	.	1LP	.	.	.	.
:45	.	.	4D3	.	.	3L4	.	.	.	2DS	.	1LP	.	.	.	.
:00	.	.	4D3	.	.	3L5	.	.	.	2DS	.	1LP	.	.	.	.
:15	.	.	4D2	.	.	3L5	.	.	.	2DP	.	1LS	.	.	.	.
:30	.	.	4D1	.	.	3L5	.	.	.	2DP	.	1LS	.	.	.	.
:45	.	.	4D1	.	.	.	.	3D5	.	2DP	.	1DC	.	.	.	.
:00																
:15	.	4D4	.	.	.	.	.	3D5	.	2LP	.	1DC	.	.	.	.
:30	.	4D3	.	.	.	.	.	3D5	.	2LP	.	1DC	.	.	.	.
:45	.	4D3	.	.	.	.	.	3D4	.	2LS	.	1LC	.	.	.	.
:00	.	4D2	.	.	.	.	.	3D3	.	2LS	.	1LC	.	.	.	.
:15	.	4D1	.	.	.	.	.	3D2	.	2LS	.	1LC	.	.	.	.
:30	4D3	.	.	.	.	.	.	3D2	.	2DC	.	1L1	.	.	.	.
:45	4D3	.	.	.	.	.	.	3D1	.	2DC	.	1L2	.	.	.	.
:00	4D2	.	.	.	.	.	.	3DC	.	2DC	.	1L2	.	.	.	.
:15	4DC	.	.	.	.	.	3D4	.	.	2LC	.	1L2	.	.	.	.
:30																
:45																
:00																
:15	4LC	.	.	.	.	.	3D4	.	.	2LC	.	1L3	.	.	.	.

FIGURE 10 Crane assignment program.

TABLE 6 Crane Production Objectives

Terminal A (throughput <250,000 containers/yr)		Terminal B (throughput [illegible] containers/yr)	
Operating Load (% of capacity)	Moves/ Crane/Day	Operating Load (% of capacity)	[illegible]
30	720	30	[illegible]
20	660	20	[illegible]
50	600	50	[illegible]

tired
itional

TABLE 7 Crane Utilization

Annual Throughput (in moves)	Required Crane Hours	[illegible] Cranes	[illegible]
400,000	13,500	[illegible]	[illegible]
500,000	16,875	[illegible]	[illegible]
600,000	20,250	[illegible]	[illegible]
700,000	23,625	[illegible]	[illegible]

[a]Percent of maximum available crane time [illegible]

FUTURE TRENDS

The past 10 years have shown that productivity [illegible] during periods of rapid terminal development. [illegible] key items for terminal development.

The following points should be considered

- Volume forecast is important for terminal [illegible] order to provide systems, equipment, [illegible] management in time, and preferably [illegible] volume increases.
- Market changes m[illegible] continu[illegible] good product develop[illegible] [illegible]ble 9[illegible] relevant in a West-Eu[illegible] [illegible]nvir[illegible]

TABLE 8 Key Items Affecting Terminal Development

Volume
Market changes
Shipping line characteristics
Mainport influences
Labor conditions
Informatics development

a tendency to lower price levels. This will sometimes block further productivity improvements.

The terminal's income development may be as shown in Figure 11, which shows that there is only one way: control and reduction of relative personnel costs. This has caused the improvements in technology presented to us over the past 5 years. If this tendency continues, it might be necessary to further mechanize and automate terminal systems and intensify management control systems.

• Shipping-line characteristics have changed over the last 5 years. Some major characteristics are given in Table 10. It is clear that terminals have to cope with these characteristics that have recently resulted in a demand for more productivity (especially at the quay-side) at lower costs! How long can the industry cope with these controversial developments?

• The development of labor conditions is outlined in Table 11. Throughout the world, labor in ports has held a very strong position during negotiations, and labor cost developments in Western European ports too have exceeded developments in other industrial areas. Round-the-clock operations really obstruct the required communication between shifts; this may also block productivity improvements.

• A final point is the development of information technology, presented by Table 12. The achievements of better productivity will probably be determined by the degree to which terminal management is successful with the application of improved information control systems and other new developments in this field.

All of these trends must be absorbed by terminal management; the large (often multiuser) terminals are faced with a variety of trends, which are summarized in Table 13. It is clear that some of them will be in conflict with the drive for further productivity.

Competition from other ports
Position of terminal with regard to hinterland
Overcapacity in port facilities
Subsidies of ports

Result: Lower price levels

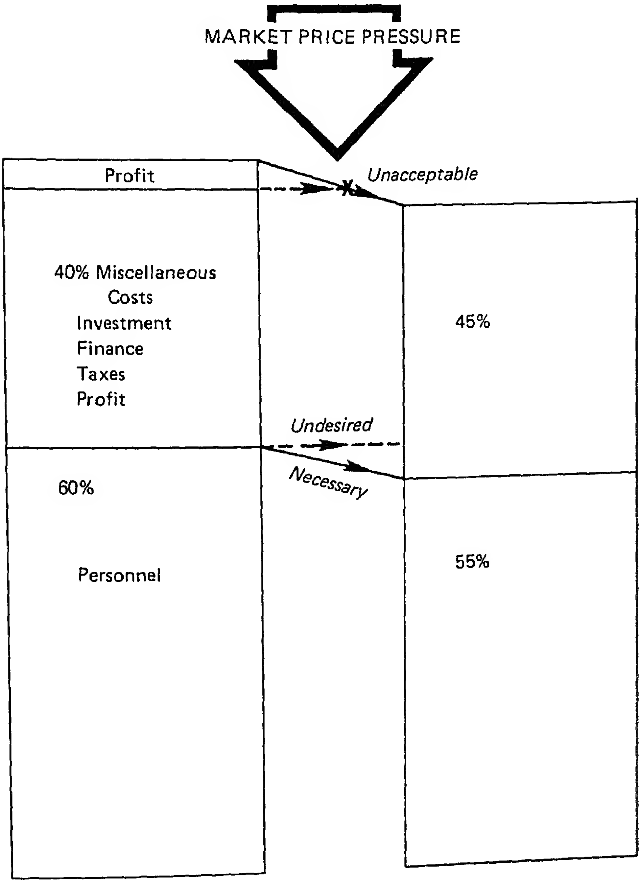

FIGURE 11 Income development.

TABLE 10 Changes in Shipping Line Characteristics

30 percent growth in TEU fleet capacity during 1983-1986
Maximum 24 hours per call, regardless of call size
Production guarantees
Soft commitments
Changes in modal split
Door-to-door management requires flexibility and last minute decisions

TABLE 11 Factors to Consider in Improving Labor Conditions in Marine Terminals

Maintaining and possibly improving good working conditions
Maintaining level of payment and fringe benefits
Reduction of working hours
Continuous labor schemes in 24-hour operations result in communication problems

TABLE 12 Considerations in Advancing Information Technology

Integrated networks between terminals and ports; harbor information systems linking agents, customs, and major consignees
Voice input
Automated identification systems
Decision support systems
Expert systems
Simulations
Animations
Computer-supported logistics and processes

TABLE 13 Trends for Large Container Terminals

Large volumes with increasing relay cargo
Productivity increase
Diminishment of personnel cost
Increasing services for shipping lines
Flexibility
Better peakability including weekends
Improved process control
Decrease in maintenance and damage cost
Increased usage of simulation and animation for the analysis of productivity and process improvements

OPPORTUNITIES FOR BETTER PRODUCTIVITY AND COST CONTROL

It is not possible within the context of this presentation to deal with all the opportunities management may have for productivity improvement and cost control. However, here are some of the most important ones:

- fewer containers on deck (reduced lashing);
- less sensitivity to container weight;
- no 20-foot boxes in 40-foot cells;
- limited damage inspection for containers (see car-rental systems);
- limited random checking of container contents;
- remote monitoring of reefer temperatures;
- complete pre-information on connecting incoming modes of transportation;
- exact information about weight, number, and type/size;
- pre-information before discharging (12 hours and preferably 24 hours);
- real closing time before ship arrival (e.g., 6 hours);
- integration of customs activities;
- integrated information systems with shipping lines, customs, and agents;

• avoidance of strict relationship between rail-car number and container number (more block trains);
• flexible working hours for casual labor;
• better use of shift labor;
• selection of operators based on operating skills;
• better training/education for labor;
• job-rotation for multiskilled labor;
• better decision tools for middle management;
• reliable automated identification systems (both for equipment and containers);
• fewer preferences (to avoid digging) for empty box delive
• more reliable equipment;
• management information systems; and
• expert systems.

Some of the suggested measures may be far away from rea tion; others may be in conflict with current rules and pract It is in the interests of container transportation to examin opportunities and to start programs that will result in better ductivity with controlled cost.

It is a challenge for our industry to cooperate and to devel systems approach. Terminals will become a nucleus of activ in this future field.

Technology, Operations, and Productivity at Marine Terminals of Scandinavia

CALLE WESTMAN

As a representative for Scandinavian liner shipping and company that participates in liner shipping activities worldv I might now and then find it difficult to restrain myself to only about that specific corner of the world called Scandin My paper, whether intentionally or not, will be biased to favo shipowner, or his views on a port, rather than those of the operator.

Calle Westman is vice-president of Transconsultants AB of Sweden.

the traditional labor-intensive method, their first approach dealt with the vessel. Advanced technology and automation resulted in reduction of manning onboard. High speed at sea made the voyages shorter in time; better material and higher standard of components made the ships more reliable, and thus fewer repair days needed to be set aside. Cargo-handling techniques remained basically the same. With few improvements in cargo handling, the time spent in port remained the same in absolute terms, although since improvements in vessel operations shortened voyage times, the percentage of total vessel time spent in port increased.

The simple truth that ships in port do not earn any money became obvious. The interest swung toward handling efficiency, but only step by step:

- Wooden hatchboards became button operated steelhatches.
- Derricks became cranes.
- Superstructures of the ship were moved aft or forward to allow cargo to be stowed in the square part of the hull.
- Forklifts became common.

The direct result was an increased productivity in the onboard and on/off handling. The bottleneck moved from ship to shore, shoreside responded with a greater degree of preassembly, and unitizing of cargoes and productivity was again in balance. The marine industry entered the high-tech era that has resulted in such extremes as the 4,000+ cellular ship, the deep sea roll-on/roll-off (RoRo) ship, and the multideck rail ferries.

The implication on the marine terminals is great as the same terminal might have to serve many different types of ships. Second, the scale effect on ships does not only mean that each vessel is much larger today. It quite frequently also results in fewer ships calling, i.e., terminals are requested to provide high capacity with quite extended intervals in between and for a great variety of ships where each type of vessel requires its specific specialists.

Many ports still need a further rationalization to come to grips with these problems.

TERMINAL TECHNOLOGY

Quite often we have been asked to participate already at the design stage. My first recommendation is to involve the customers.

Crucial aspects are:

- Easy access from sea as well as good hinterland connections, both rail and road;
- open large areas required for most port operations today;
- ground preparation for heavy loads;
- lighting;
- a functional layout that follows the structure of the physical work;
- large free-span sheds that allow true mechanical handling; and
- handling-equipment flexibility, based on sturdy standard units with interchangeable attachments for specific purposes.

Terminal Access

The ports in Scandinavia were by tradition situated in well-sheltered areas both against weather and foe, and this results in rather time-consuming pilotage. Modern terminals require more land, which cannot be found within the old areas. Better rail and road connections are also necessary and can hardly be arranged economically at old inner city areas.

Consequently a movement toward river-mouth and fjord entrances can be seen, where land, if not available, can be reclaimed and where direct connections with highway and railway systems can be made. That the ship's port maneuver times are cut by an hour or two are spin-offs that are fully appreciated.

Open Areas

With a higher degree of mechanized handling the old finger-pier with a narrow 20-foot apron became a problem. Direct intermodalism is no longer a help but rather an obstruction to productivity and can only be used in rare instances and under very specific conditions.

To use the handling capacity of a modern general cargo vessel, all cargo should be received and unitized prior to arrival. Cargo

cupies as a rule of thumb three to four times greater an area hore than onboard, and the area required for a specific vessel or .e can then be calculated on the following basis:

- export cargo;
- import cargo;
- access roads;
- marshalling area; and
- service area.

A general cargo terminal must also be capable of handling coniners which, once involved, tend to breed like rabbits and over-w any area if not kept under strict control.

Solid Ground

Many an ingenious large-unit project has literally sunk rough at older terminals. Heavy forklifts produce axle loads 80-100 tons today. A modern terminal must not only comply th the requirement of today, but also have a built-in reserve for e ultralarge units that can be seen on the horizon.

Lighting

Highly mechanized handling calls for good lighting. The single ip's cluster that was enough has to be replaced by efficient light-wers. Type of light used should take into consideration that lor-coding is still a very good and frequently used method for entifying cargoes.

Functional Layout

Separation of the different activities, i.e., a structuring of the ork within a terminal, is necessary to increase both productivity d efficiency. The following four basic activities may require rther breakdowns to suit a specific terminal or a specific instance t can generally serve as an indication on how to tackle the oblem.

1. Activity A—Loading and discharge of ships.
2. Activity B—Reception and delivery of large units (i.e., con-iners, empty or full).

3. Activity C—Stuffing (vanning)/stripping (devanning) cargo units or unitizing of cargo.
4. Activity D—Reception and delivery of loose general cargo

Large Free-Span Sheds

Modern mechanized handling requires free unobstructe spaces indoors as well as outdoors. The door openings must b wide enough to allow a 20-foot wide unit to pass at speed.

Scandinavian main ports have in many instances been luck enough to start off fresh on new land, but where it has not bee possible, old sheds have been pulled down and substituted wit new lightweight constructions with large free-span beams withou any traffic hindering pillars.

Some ports have converted the sheds to opensided traile garages and others have at least widened up the shed doors allow the magic 20-footer to pass, even if not everybody has bee so drastic as the port engineer in Mozambique who let a hu bulldozer pass through the wall until I was satisfied.

Door heights should allow any piece of equipment to pass, an the 20-foot figure is again appropriate.

Handling Equipment

Gantry cranes are used for pure container handling in the ma ports. We have not till now seen anything but the plain standa ones. Smaller ports prefer mobile harbor cranes with contain capacity. Standard multipurpose railborn harbor cranes with c pacities of 3-5 tons are disappearing.

Wheelborn portainers are used for reception and delivery of ra carried boxes. Transport from portainer to stack and from sta to gantry is usually performed by terminal tractors and traile with large forklifts serving the stack. Yesterday's heavy forkli of 25-ton capacity are today dwarfed by 40-50 tonners. Termin tractors with trailers and heavy forklifts are also used to ser RoRo ships that are quite abundant in our part of the world.

A long array of special equipment make these standard vehic do all sorts of tricks:

- skeltrailers;
- bathtub trailers;

- heavylift trailers;
- toplift frames;
- sidelift frames;
- pulp clamps;
- reel clamps;
- coil prongs; and
- fifth wheels.

All rolltrailers today used for terminal shuttle traffic have goose necks attached permanently. A tough climate, and just as tough unions, require all vehicles to have fully enclosed cabins.

To meet the rather heavy investments necessary for a good marine terminal, we have seen a change in the port-owner/port-operator configurations in Sweden. Private stevedores have amalgamated step by step into larger and larger companies. In most ports there is only one stevedore left, which often maintains the private company construction, but with the municipality as the majority owner.

TERMINAL OPERATION

As stated earlier, first it is essential to structure the layout of a terminal in a functional way and thus enable a structured operation. Second, all work should be preplanned to the largest possible extent, physically as well as economically.

Preplanning has long traditions in shipping, probably from the day a poor viking supercargo had to abandon a good loot on a foreign shore. Pure container handling introduced the need for sequencing, i.e., a structured resource planning. Together with some terminals we have developed it further, and prior to each call, we presequence general cargo RoRo ships with the help of a rather simple form.

But having realized the need for preplanning and sequencing of the actual shipwork, we are introducing a structured reception and delivery of cargo to further control and diminish the waste of money. To get acceptance from the market we might introduce, together with the terminals, an Executive-Apex system where different degrees of service pay different terminal-handling charges.

Just as important as the pre- and ship-operational work, but less glamorous, is the postoperational work. The cargoes must move out of the terminal. Sadly to say, it is worldwide more a function of customs ability than that of the terminal-operator, and thus more of an organizational matter than a practical one. Nevertheless, it is an important factor that has a great influence on the terminal cargo turnover and should be approached in an openminded way. Great steps have been made by introducing online computer-based information systems.

Flexibility is another key word. Resources, whether men or equipment, must be interchangeable. Anybody in a terminal should be able to handle a forklift professionally. Some terminals have also succeeded to persuade the unions of the need for flex-time. The shift may start 0700-0900 in the morning and continue for 8 hours to avoid waste of money.

As the ports of Scandinavia as well as the Scandinavian Shipping Lines live in a very competitive world, we have made common marketing efforts where quality and efficiency has been our basic message.

Productivity

As port calls do not earn a shipowner any money, but still must be regarded as necessities for the whole business venture, it is essential that time in port is used for the good, i.e., for cargo operations, and not wasted or, in other words, that port time is minimized. If there is an option, the choice should be given to the port with the best productivity per port-hour, which does not necessarily equal that one with the best production per stevedore hour. Port time in this context is seen as opposed to sea time, where sea time is the part of a trip over which the line has full control through the master of the ship. Consequently, port time starts to run upon arrival at the pilot station inbound and ends upon disembarkment of the pilot outbound.

The impact of nonproductive time is greater today when operational port time gets shorter. Following is a comparison of two different port calls, each involving a liner with 4,000 tons of cargo to handle. Port A lies up river, and pilot to berth is 4 hours in, 4 hours out. Port B lies closer to the coast and requires only 2

hours in, 2 hours out. Port A has a good stevedore producing 400 tons/hour.

PORT	IN	OUT	STEV. TIME	TOTAL TIME	TONS/PORT HR.	TONS/STEV. HR.
A	4	4	10	18	222	400
B	2	2	14	18	222	286

The stevedore in port B can produce 29 percent less per hour, but still equal port A in tons per port-hour.

As terminals in Sweden that are capable of handling large deep-sea vessels have diminished in number to a mere handful and for large pure cellular vessels to a single one, the possibility to substantiate a threat of going somewhere else in Sweden is close to nil, especially when the line's competition in the optional north European ports is much more aggressive. The line's policy, thus, has been to seek cooperation with the ports. Productivity is directly a consequence of better technology. Each phase of development we have been through has resulted in increased productivity. But as the labor force engaged has become less in numbers, the importance of motivation has increased.

High productivity and few individuals make the modern integrated system more vulnerable to disturbances. Almost any individual involved can influence the total operation, and with an hourly production of 400-500 tons, there can be quite a stack of cargo left ashore when time for departure arrives if the stevedore has just been working and not been working for you.

Contract formats can be used to steer the dealings with a terminal as such. Control systems can be developed to check in minute detail, but only good everyday relationship and mutual respect can give that extra boost needed for good motivation and thus production.

Productivity of Canadian Marine Terminals

RICHARD KUSEL

Since terminal technologies are largely affected by many factors inherent in the overall transportation scene in the particular area, I will very briefly try to give you the economic and logistic perspectives as they exist in Canada and affect the Canadian transportation system as a whole.

Canada is a small country. In terms of population, we are only about 25 million, more than two-thirds of which live in about a dozen cities spread from the Atlantic Coast to the Pacific Coast over some 5,000 miles of distance. We have only four ports that have operative container terminals, i.e., Halifax; Saint John, New Brunswick; Montreal; and Vancouver. In these ports there are only seven container terminals that handle over 50,000 TEUs.

These ports, the 10 major cities, and all container terminals are interconnected with two major railroads (except Halifax, which is served by just one railroad). Otherwise both railroads span the country from coast to coast with no interchange necessary to and from any major city or market across Canada. This extensive and uninterrupted rail system interconnecting all terminals is one of the factors that significantly influences the terminals' productivity as well as the whole intermodal transportation system in Canada.

Although Canada is small, it is very much a trading nation. Over 30 percent of our gross national product is derived from the international trade. A large portion of our production in forestry, mining, and agriculture is exported, whereas you know that Canadians are avid buyers of foreign goods as evidenced by substantial imports through our ports.

Canada has, from its beginnings, relied on the railroad to move its products from and to its ports, and it can be rightly said that the two major railroads are the backbone of Canada. These same two railroads have been instrumental in the development of Canadian intermodal transportation technology in both inland rail and port terminal interfaces, and in particular the technology

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Richard Kusel is president and chief executive officer of Canada Maritime Agencies Limited, Montreal, Canada.

of evacuation of containerized traffic from the port terminals. One railroad is owned by the Canadian taxpayers through a Crown Corporation called Canadian National Railway, the other by the public through a publicly held company, Canadian Pacific Railroad. Both are giants and successful, and while their ideologies of operation may differ from time to time, both railroads have developed extensive container flat-car fleets, have equipped inland terminals, and have participated in development of port terminals, thus creating compatible and smooth ship/terminal rail and truck interfaces creating, in my opinion, one of the best and truly intermodal systems anywhere. Another significant factor affecting terminal productivity is practically a total absence of the trailer-on-freight-car mode of container transportation in both Canadian terminals and rail systems.

The container-on-freight-car (COFC) system results in substantially lesser space requirements in container terminals themselves (no space required to park chassis) and eliminates the need for each container to be married to a chassis through its import/empty and export cycle and, above all, this system eliminates duplication in transportation, i.e., container lies on chassis and chassis lies on rail car during long rail transits. This means significant savings for the shipowner or service operator, as well as for the terminal operator.

In three of the four container ports in Canada, i.e., Halifax; Saint John, New Brunswick; and Vancouver, less than 20 percent of cargo originates locally. In the case of Montreal, the percentage is slightly higher; nevertheless, the majority of cargo also originates elsewhere. Exactly the same patterns are evident for the inbound cargoes.

In summary, these peculiar traffic patterns, coupled with comprehensive rail networks across Canada and parts of the United States, vast distances between major points of origin and destinations have engendered specific technologies of cargo evacuation from Canadian terminals, the most important elements of which are as follows:

1. Most of the cargo is evacuated on the rail in COFC mode, leaving smaller portion of cargo at terminals to be trucked. The

same pattern exists on the outbound cargo. This results in relatively smaller terminal space requirements, enhances direct ship-to-rail transfer and, coupled with block stowage on the ship and terminal, permits double cycling very frequently.

2. Unit or dedicated trains with fixed and regular schedules exist between all major origin or destination terminals, all of which are equipped with lifting equipment for each pick-up and delivery and return of empties on the terminals. This enables the movement of large numbers of containers over long distances very fast at realistic costs and at a predictable, regular schedule.

3. Weather elements in Canadian ports and terminals can be severe. Ice breaking, snow cleaning, and snow removal from terminals engendered new and specific technologies that now permit uninterrupted operation in adverse weather conditions. In fact it is mostly the speed of the wind that stops terminal operations in Canada, and this is the same reason that operations are interrupted elsewhere in the world.

This general scenario and its peculiarities influence significantly the productivity of terminals in Canada, as they do the overall transportation system of which the terminals are one of the critical elements. The same general factors that influence the cost also vary significantly, which in turn makes container terminal and whole transportation costs very competitive in Canada.

I will now elaborate on the productivity elements that are specific to the port of Montreal on our own container terminal in that port (see Figures 1-6).

A. Labor in the port of Montreal and our terminal are members of the International Longshoreman's Association (ILA). Good labor relations exist between the employers association, the terminal management, and ILA, which are essential for productivity. Some of the items that further enhance good relationships and productivity are training and job security. The amount of $38,184 has been spent in the last 5 years for ILA labor training, mainly to handle container cranes, transtainers, and lifting equipment.

As you can note we have consistent improvement in productivity, and while this may not appear spectacular, the actual labor hours are used, and times for breaks or opening and closing hatches are included.

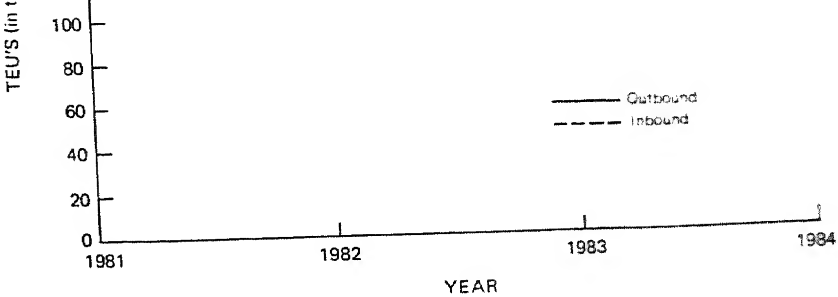

FIGURE 1 Containerized cargo at the Port of Montreal.

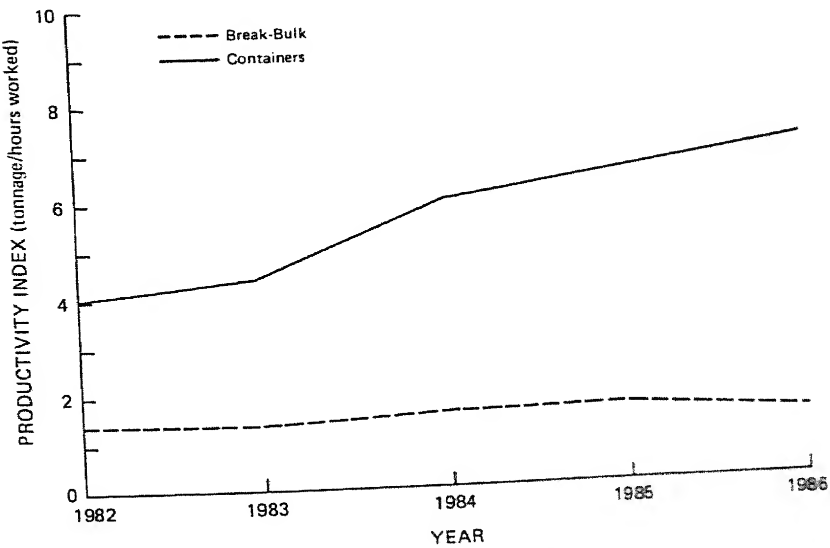

FIGURE 2 Productivity at the Port of Montreal.

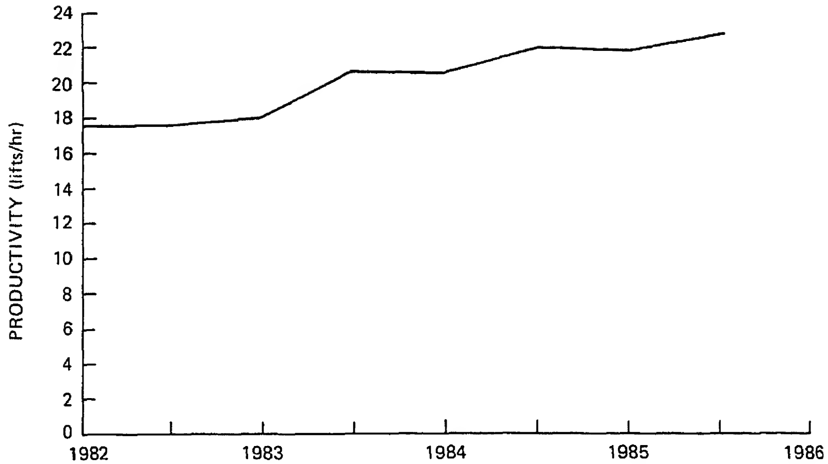

FIGURE 3 Productivity of cranes at Racine Terminal, Montreal.

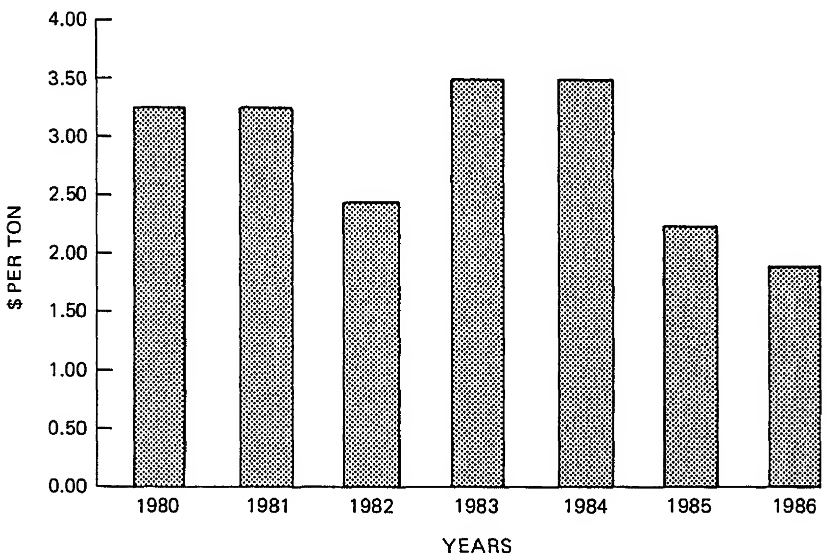

FIGURE 4 Cargo assessments used for ILA job security and administration—Montreal.

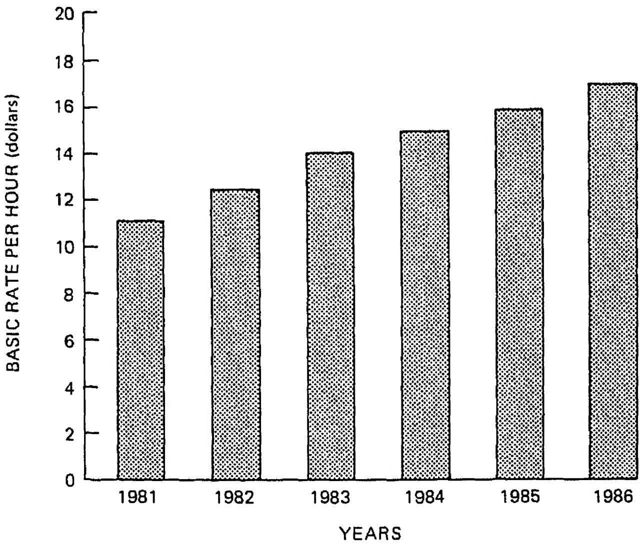

FIGURE 5 Longshoremen's wages—Montreal.

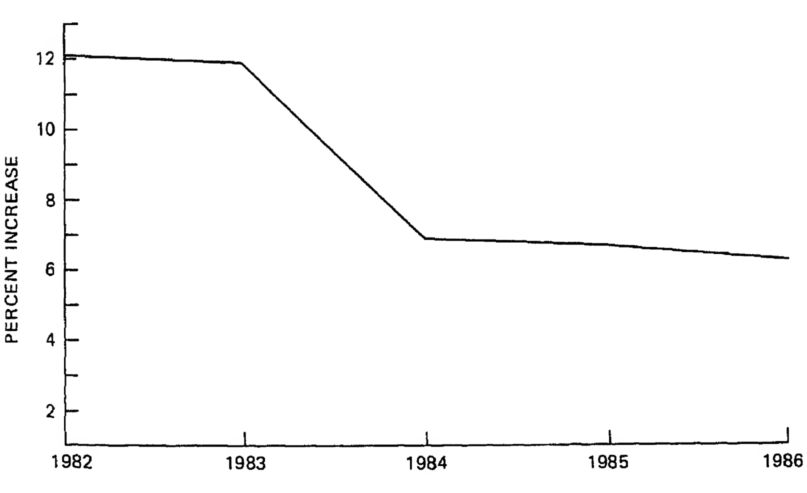

FIGURE 6 Yearly increases of longshoremen's wages—Montreal.

B. Cargo assessments used for ILA job security and administration have been decreasing with increasing productivity and increased tonnages.

As you see from Figure 4, the decrease of assessments are quite significant, and they are contrary to the trends in some major ports and terminals in many parts of the world. Again, the reduction in costs in this area is a very important competitive factor and is a direct result of the improvement of productivity at the port and its terminals.

C. Equipment in use and terminal layout are consistent with COFC technology and the traffic patterns in Canadian ports. The actual equipment in the terminal is three PACECO portainer cranes for ship/shore handling and four PACECO transtainer cranes for rail loading/unloading. Shuttle between shore cranes and transtainers is effected by only 20 yard trailers and 20 yard tractors. Eight high-capacity front-end lifters are used for empty in and out, local import, and block prestowage on the terminal.

The terminal is handling, at the described productivity level and with the described equipment, 168,000 containers in 1985. It is making good money at competitive rates.

CONCLUSION

Lots of work, organization, and capital have been expended in Canada to create viable and cost-effective transportation systems. No single person or company can claim the responsibility or credit for the success our system is enjoying. If I were to name a specific cause of the success, I would say that it is the ability of the people with varied interests to work together. This includes labor, steamship companies, railroads, port and transport authorities, and the shipping public itself. It is this factor, in my opinion, that will dictate more than anything else the productivity of any terminal.

THE IMPORTANCE OF PRODUCTIVE, EFFICIENT INTERMODAL TRANSPORTATION FOR INTERNATIONAL COMPETITIVENESS

ROBERT KLEIST

The business of world trade is exceedingly competitive, but with tremendous opportunities for the United States as well as for the rest of the world. There is lots of world trade; it needs stimulation, and it needs productive transportation available in order for it to succeed. Productivity in the liner industry, in ports, and in the whole intermodal process is important to the business of world trade.

Port productivity cannot be measured simply in terms of terminals, wharves, cranes, and people. It must include the port's location as well as the political, social, and environmental attitudes of the people it serves. There are many external influences over which the port management has little control.

World trade grew at the rate of about 9 percent in 1984, and probably at a rate of 5 percent in 1985. Total world trade between all nations in 1984 exceeded $3 trillion. The United States was responsible for more than half a trillion, $543 billion out of the total of $3 trillion. Imports to the United States amounted to $323 billion, exports to $220 billion, leaving the United States

Robert Kleist, who presented the closing address at the symposium, is vice-president of Evergreen Marine Corporation.

with a deficit in 1984 of $113 billion. Sadly, in 1985, the deficit in our export account is expected to reach $140 billion. When you take a look at this, it isn't too hard to understand that the balance of cargo movement between the United States and almost everywhere else is decidedly one-sided.

A little bit of the history of world trade is in order for those who may not be all that familiar with it. Before World War II, the United States engaged in two-way trade to the extent of approximately $30 billion per year. Of course, U.S. participation in world trade had been adversely affected by the Smoot-Hawley Act, protective tariff legislation passed at the beginning of the Depression to protect American industry. Actually, it probably drove more American industry out of business than it protected. After World War II, American business began to pay more attention to the value and the potential of international trade. Yankee traders traveled around the world and did a very good job of selling more than just simply American goods, products, and services. They also sold American ideals. Those of us involved in international trade in the early 1950s recall a lot of talk to the effect that "you can't expect to export unless you import," because the nations of the world need to earn dollars in order to buy U.S. exports.

Obviously, when you take a look at today's $113 billion deficit, we oversold the case considerably. The United States had been running at the rate of $7 billion to $10 billion surplus in our trade account, and now the country is paying for it with interest.

What are some of the factors that influence productivity in our industries, and how do they affect international trade? What does our collective transportation system need to do? What do we need from each other, to not only handle international trade, but to contribute to its well being? What are the factors that affect or limit our industry's productivity, and how do we view the role of the ports and other intermodal elements in the scheme of things? What do we need, and therefore what do we expect, and what can be expected of us? How do we view the effect of the productivity of the respective elements, particularly the ports, on our activities?

In looking into what the people in world trade think about the matter of productivity, I found a report made by the famous accounting and consultant firm of Touche, Ross and Company. One of the articles in the report was written by Thomas J. Murrin of Westinghouse. In his conclusion he wrote,

We will delude ourselves tragically if we think that there are substitutes for improved productivity and quality in our efforts to maintain the standards of life that have made our country the envy of less fortunate lands. If our nation as a whole regards productivity as a matter affecting only corporate balance sheets or stockholders' dividends, little will be achieved in meeting the productivity challenge. But if all of us come to see productivity and quality for what they in truth are, crucial elements, not only of our personal prosperity, but also our capacity to thwart Soviet ideological and military ambitions, then they will become achievable. Although the challenge we face is a formidable one, the United States should not be presumed to be the latest in the long list of countries that used to enjoy world economic leadership. No other nation ever has possessed human and natural resources of the nature and magnitude of ours. We can prevail if we do our best. Nothing more is needed, but nothing else will do.

I spent about a year with the Pacific Far East Line in Japan observing productivity Japanese style. One experience in particular showed me the importance attached to productivity by that trading partner.

One of our ships happened to have the misfortune of running into a tanker after it had departed from Tokyo. It came back under its own power into Tokyo Bay, arriving at about five o'clock in the morning. I had been alerted to it and was on a launch out to the ship before daybreak. Instantly at daybreak there were three potential repair facilities that had their launches out inspecting the damage to the ship. It was hardly possible that they could have even known about the accident, because it had only occurred about 6 hours earlier. But somehow, whether people still talk about Japan, Incorporated or not, it really works as if it's incorporated. Within 12 hours we had made an agreement to take the vessel into an available dry dock. I was instructed by our head office to have temporary repairs made to the ship. We gave the order for temporary repairs, and they were done in about 72 hours—a large hole in the hull had been patched, a crack in the propeller had been repaired, and the vessel was again out to sea. When it arrived back in San Francisco for its permanent repairs, the inspection proved that the temporary repairs were better than the permanent repairs would have been had they been performed elsewhere. That was the level of productivity, the quality of the work that was done.

The productivity of a port directly influences its ability to attract cargo. Who would have expected, for example, that cotton grown in California would be exported from the United States through the Pacific Northwest? For years, cotton moved through the ports of Los Angeles and Long Beach. North San Joaquin Valley cotton was shipped through the ports of San Francisco and Oakland. For a few years, the Port of San Diego made an intrusion into the cotton export market, and received quite a bit of the cotton from across the Mexican border at Mexicali. Subsequently the Mexicans opened the Port of Ensenada; that ended significant cotton exports from the Port of San Diego.

So it was until several years ago, when an enterprising shipping company executive figured a way to move cotton at a very advantageous intermodal rate from West Texas up through the ports of Seattle and Tacoma. Thus, a port that never dreamed it would have cotton exports captured a large share of the trade as a result of the most-productive, least-cost intermodal innovation.

Another question is, just how unproductive can ports become when they serve a captive area of 15 million people? Is Long Beach/Los Angeles an area where a port simply cannot fail? Quite likely that is a possibility. But blessed by a neighboring competitor, each of these ports has become a vital and major intermodal link with high productivity. So competition is clearly a factor in motivating port and intermodal productivity. The ports have jointly planned for their future. The plan, called the 2020 plan, calls for reclaiming 2,419 acres of land; 500 acres will be developed outside the breakwater.

An intermodal truck-rail container transfer facility is another recent development. This facility will be able to accommodate up to eight unit trains simultaneously. It is located strategically at about the center point of a line running north joining the two harbors, Los Angeles and Long Beach, a maximum distance of 5 miles from the marine terminals, and as close as 2.5 miles to the nearest terminal in Wilmington and the northern area of the Port of Long Beach. This facility will replace the current rail intermodal terminal, which is between 25 and 27 miles from the harbor. This is the type of productive facility that the Ports of Los Angeles and Long Beach are developing for the accommodation of international trade.

One of the critical issues in improving productivity is the matter of people and their performance. My company provides extensive personnel training. It operates a fully operational, 440 TEU container training ship that accommodates 200 cadets. Each cadet spends 1 year in training aboard this vessel after having taken basic seamanship and basic training. I mention this simply as an example of what the liner industry is doing to accommodate world trade.

What is the volume of trade, in a practical sense, that needs to be handled? My company operates around-the-world service in both east and west directions on a weekly basis. Most of that service is provided by vessels capable of lifting 2,728 TEUs. If you put two 40-TEU units on a railroad car, a 50-car unit train would carry 100 40-foot containers. It would take 13.5 unit trains, which would measure 10.2 miles of railroad track, to fill one of these ships one time. That certainly is less than would be required by some of the ships that are coming onstream now, which can accommodate up to 4,000 containers. So that is a measure of the extent of cargo implied in the figure of $3 trillion worth of world trade.

Facing the reality that the future of U.S. participation in world trade demands the utmost productivity from us, how do we in the liner industry view our own productivity, and how do we approach the need for improvement? We need to appraise our knowledge of our own business, our resources (financial, technological, and human), our resourcefulness, our ingenuity, our imagination, our courage, and our competence. All of these we can do something about, and we'd better, or get out of the business.

We need to compare our facilities and services with those provided by others. We need also to consider the environment in which all of this takes place.

People are particularly important—our organization, our management team, the work force, labor, organized labor, and others. The public's perception of what we do and why, and how it affects them, is also important. It influences productivity to have your company in the headlines of even a local paper. This can be an influence for productivity, but it also can be a counterproductive influence.

It is also helpful to understand the staffs and the commissions of the organizations with which we do business. How often are we really working in the same direction? The customers themselves

need looking at—this is the most valuable of all factors, and the object of the whole exercise.

Finally, government policies and rules affect our activities.

So we come to the conclusion that we're all in this together, and that's why I have expressed the optimism that I did at the outset. Here we are with some of the best and most conscientious minds in our great country, with the added supercaliber input from abroad, discussing the means by which we can actually become more productive.

The age of the Pacific, referred to by Richard King (in this volume), is the most dominant force in world trade. Through intermodalism as well as by direct all-water service, we have the great opportunity to participate in and to benefit from it. Port and intermodal productivity is a vital force in the future of world trade.

The great British historian, Arnold Toynbee, said, "I'm glad that I'm growing old in England. Americans are dedicated to the new and super efficient. It must be depressing to be old in the United States." Wouldn't that be a sad commentary to have to make about yourself and about the area in which you have lived and are living?

Although the challenge we face is a formidable one, the United States should not be presumed to be the latest in the long list of countries that used to enjoy world economic leadership. No other nation ever has possessed human and natural resources of the nature and magnitude of ours. We can prevail if we do our best. Nothing more is needed, but nothing else will do.

APPENDIXES

APPENDIX A BIOGRAPHIES OF COMMITTEE MEMBERS

CHARLES F. CONNORS joined the Port of Long Beach in 1956 and was appointed chief harbor engineer in 1979. He was promoted to deputy executive director in 1983. Mr. Connors has acted as chief project engineer for several terminal and infrastructure projects, and served as engineering consultant in the port's first trade mission to China. He has a bachelor's degree in engineering from the University of California, Long Beach.

HUGH M. LACEY retired in 1986 as vice-president, land operations, of Sea-Land Service, Inc. Sea-Land Service is the container ship operating subsidiary of Sea-Land Corporation, a diversified ocean freight and land transportation firm. Prior to joining Sea-Land in 1961, he directed trucking companies and intermodal terminals. Mr. Lacey graduated from St. Joseph's College Institute of Labor Relations and the Academy of Advanced Traffic.

HENRY S. MARCUS has been at Massachusetts Institute of Technology (MIT) since 1971 and currently holds the positions of associate professor of marine systems in the Ocean Engineering Department and chairman, Ocean Systems Management Program. He has also served as a transportation consultant to maritime industries and government. Dr. Marcus holds a bachelor's degree

in naval architecture from Webb Institute, simultaneous master's degrees in naval architecture and shipbuilding and shipping management from MIT, and a doctorate in business administration from Harvard University.

ROBERT J. NOLAN is executive vice-president for administration of International Terminal Operating Co., Inc., a stevedoring and terminal operating firm in more than 20 ports of the United States. He is a graduate of the U.S. Merchant Marine Academy, the Georgetown School of Foreign Service, and Seton Hall Law School. He is a member of the New York Bar and past president of the National Association of Stevedores and the National Maritime Safety Association.

RUDY RUBIO has been a longshoreman since 1955. He progressed from dispatcher to business agent of Local 13 (Southern California), then to secretary-treasurer and president. He was elected vice-president of the international union in 1977.

PETER G. SANDLUND is the Washington representative of the Council of European and Japanese National Shipowners' Associations. He served in progressively responsible positions with the Swedish American Line following graduation from the Gothenburg School of Economics, and when the company became a partner in the Atlantic Containerline, as general sales and marketing manager of that venture. He joined Overseas Containers, Ltd., as senior vice-president for North America in 1969, and in 1971 became executive vice-president of Dart Containerline. Mr. Sandlund has held his present position for 12 years. In addition to his degree from Gothenburg, Mr. Sandlund has a J.D. from the Cleveland Marshall Law School.

CLIFFORD M. SAYRE has worked for Du Pont more than 30 years and is currently director of logistics within the Materials and Logistics Department. He held several research and supervisory positions before joining the Transportation and Distribution (now Materials and Logistics) Department in 1977. His responsibilities have increasingly been directed to worldwide transportation of the company's raw materials and products, and to the transportation of hazardous cargoes. Mr. Sayre, who holds a bachelor's degree in

chemical engineering and several patents, has served on the Maritime Transportation Research Board and the successor Marine Board, and on the Marine Board's Committee on National Dredging Issues. He is a registered professional engineer and member of the American Chemical Society.

SVEN I. THOOLEN has been with Matson Navigation Company for 25 years and is currently director of Industrial Engineering. He developed the first container terminal operating and operational control systems in Los Angeles, Oakland, and Honolulu, and has since designed container-ship terminals, control procedures, and computerized tracking systems. He has a bachelor's degree in industrial engineering from the University of California, Berkeley, and has published extensively on the application of industrial and systems engineering to container handling, intermodal transportation, and automated cargo handling and tracking.

WILLIAM C. WEBSTER has been a faculty member of the Department of Naval Architecture at the University of California, Berkeley, for the past 16 years. He holds bachelor's, master's and Ph.D. degrees in naval architecture from Webb Institute and the University of California. In recent years, he has developed engineering solutions to loading and unloading a variety of containers and container ships more efficiently as a consultant to American President Lines and other clients. Dr. Webster is [illegible] chairman of the Marine Board of the National Re[illegible]

APPENDIX B
LIST OF PARTICIPANTS

National Meeting on
Productivity of Marine Terminals
Long Beach, California
January 8-10, 1986

Committee

Clifford M. Sayre, *Chairman*, E. I. du Pont de Nemours & Co.
Charles F. Connors, Port of Long Beach
Hugh M. Lacey, Sea-Land Service, Inc., retired
Henry S. Marcus, Massachusetts Institute of Technology
Robert J. Nolan, International Terminal Operating Co., Inc.
Rudy Rubio, International Longshoremen's and Warehousemen's Union
Peter G. Sandlund, Council of European and Japanese National Shipowner's Associations
Sven I. Thoolen, Matson Navigation Company
William C. Webster, University of California at Berkeley

Invited Participants

Marge Abbott, Port of Portland

Wes Allen, Georgia Ports Authority
Ben Andrews, S.E.A.
Carmel Aquilina, Marsaxlokk Port Project, Malta
Asaf Ashar, Louisiana State University
Elmar Baxter, Port of Long Beach
Gary L. Brower, Los Angeles Commercial News
David Burns, Burlington Northern Railroad
Keith Christian, Port of Seattle
Robert A. Curry, California Cartage Co., Inc.
Thomas Dowd, University of Washington
Greg Doyle, Louisiana State University
Mary Dyess, National Association of Stevedores
Joel Fadem, University of California at Los Angeles
Robert Fall, Sea-Land Service, Inc.
Marty Frates, IBT Local 70
Nancy Friedman, Advanced Technology, Inc.
Michael Gaffney, Cornell University
Bradley Gewehr, Association of American Railroads
Roger J. Giesinger, Virginia International Terminals, Inc.
John J. Gray, Intermodal Management Services, Inc.
John Hachey, Port of Portland
Ronald Katims, Container Transport Technology
Kyle King, King Interests
Richard King, Richard King International
Robert Kleist, Evergreen Marine Corp.
Richard Kusel, Canada Maritime Agencies Limited
Gary La Bonte, Jordan/Casper/Woodman/Dobson
Lee Lane, Association of American Railroads
Jerry Lorelli, U.S. Customs Service
Brian Maher, Maher Terminals Co.
Carl Martland, Massachusetts Institute of Technolog
Jeremy Mattox, Jeremy Mattox & Associates, Inc.
Geoffrey R. McIntyre, Department of Transportation
James H. McJunkin, Port of Long Beach
Paul B. Mentz, Maritime Administration
Bill Mongelluzzo, The Journal of Commerce
Don L. Mosman, Port of Los Angeles
Frank W. Nolan, Jr., International Terminal Ope
Brendan W. O'Malley, The Port Authority of Ne
Jersey

Eugene Pentimonti, American President Lines, Ltd.
Ernest L. Perry, Port of Los Angeles, retired
Anthony Petrizzo, Maersk Container Service Co.
John Pisani, Maritime Administration
Tony E. Pittsey, Sea-Land Service, Inc.
Dan Rayacich, D. Rayacich Maritime Consultants, Inc.
Christopher Redlich, Jr., Marine Terminals Corp.
Col. Nolan Rhodes (retired), Port of Corpus Christi Authority
Joan C. Rijsenbrij, Europe Container Terminus
L. P. Robinson, American President Lines, Ltd.
J. B. Rollison, Georgia Ports Authority
Edgar Ted Rust, Williams, Kubelbeck & Assoc.
Duncan Scott, Port of Long Beach
Bob Senecal, Metropolitan Stevedore Co.
Isaac Shafran, Maryland Port Administration
Don Sheppard, International Transportation Service
Paul Sorenson, URS Corporation
Tom Teofilo, Port of Long Beach
John Verheul, Port of Oakland
John Vickerman, Vickerman.Zachary.Miller
Don Walsh, International Maritime, Inc.
Thomas Ward, Liftech Consultants, Inc.
Jack Wells, Port of Los Angeles
Calle Westman, Transconsultants AB
Larry Whiteneck, Moffatt & Nichols Engineers
Thomas D. Wilcox, National Association of Stevedores

Staff

Charles A. Bookman
Aurore Bleck

APPENDIX C
AGENDA

National Meeting on Productivity of Marine Terminals Long Beach, California January 8-10, 1986

The Queensway Bay Hilton
700 Queensway Drive
P.O. Box 20001
Long Beach, California 90801
(213) 435-7676

ednesday, January 8, 1986

Welcome—Ballroom C	Clifford Sayre, *Chairman*, Director of Materials and Logistics, Du Pont Corp.
Welcome from The Port of Long Beach	Mr. James H. McJunkin, Director, Port of Long Beach
Meeting Objectives and Organization	Clifford Sayre
Keynote Address: Trends in World Trade: Implications for U.S. Marine Terminals	Richard King, Richard King International
BREAK	
The Marine Terminal—An Element of Transportation Systems (Panel)	Hugh Lacey, *Moderator*, Vice-President Land Operations, Sea-Land Corp.

	5.1 Rail Transportation Perspective	David Burns, Director, Intermodal Dept., Burlington Northern Railroad
	5.2 Truck Transportation Perspective	Robert A. Curry, President, California Cartage Co.
	5.3 Ship Operator Perspective	L. P. Robinson, Senior Vice-President, Operations, Americ President Lines
	5.4 Intermodal Perspective	John J. Gray, Intermodal Management Services, Inc.
	Lunch—Buffet in Montego Bay Room	
6.0	U.S. Marine Terminal Technology and Operation (Panel)	Sven Thoolen, *Moderator*, Director, Industrial Eng., Matson Navigation Co.
	6.1 State of Technology	Frank Nolan, International Terminal Operators, Retired
	6.2 State of Operations	Dan Rayacich, President, Rayacich Maritime Consultants, Inc.
	6.3 Emerging Technologies—Information Systems	Nancy Friedman, Advanced Technology, Inc.
	6.4 Emerging Technologies—Human Factors	Michael Gaffney, Cornell Univ. School of Industrial and Labor Relations, and Joel Fadem, University of California at Los Angeles Institute for Industrial Relations
	BREAK	
7.0	Productivity at Selected Foreign Marine Terminals (Panel)	Peter Sandlund, *Moderator*, Council of European and Japanese National Shipowner's Associations
	7.1 Europe Container Terminus, Rotterdam	J. C. Rijsenbrij, Director, Equipment Engineering, R&D, Europe Container Terminus
	7.2 Montreal, Canada	Richard Kusel, President, Canada Maritime Agencies, Ltd.
	7.3 Scandinavia	Calle Westman, Vice-President, TransConsultants AB
	BREAK	

Long Beach/Los Angeles
• Matson Marine Terminal, Los Angeles
• Sea-Land Marine Terminal, Long Beach
RETURN

outside the Queensway Bay Hilton

9.0 Working Supper: Organizing Meeting for Work Groups
• Measures of Productivity, Their Use, and Their Role in Improving Productivity (Ballroom A)
• Issues in Improving Productivity (Ballroom B)
• Implications of Technological and Operational Factors for Competition and Trade (Ballroom C)

Thursday, January 9, 1986

10.0 Concurrent Workshops

10.1 Measures of Productivity, Their Use, and Their Role in Improving Productivity (Ballroom A)

Leader: William Webster, Dept. of Naval Architecture, University of California at Berkeley
Rapporteur: Edgar Rust, Williams, Kubelbeck & Assoc.

10.2 Issues in Improving Productivity (labor, materials handling, documentation, facilities, safety, quality, standardization, institutional constraints) (Ballroom B)

Leader: Henry Marcus, Center for Transportation Studies, Mass. Institute of Technology
Rapporteur: Gregory Doyle, Ports and Waterways Institute, Louisiana State University

Lunch—Mexican Buffet in Lounge Area

10.3 Implications of Technological and Operational Factors for Competition and Trade—emphasis on competition between modes of transport; competition between domestic ports; and international competition (Ballroom C)

Leader: Clifford Sayre
Rapporteur: Donald Walsh, President, International Maritime, Inc.

BREAK

	Cocktails and Dinner at the *Queen Mary*, —Mauretania Room	
	Dinner Address: The Importance of Productive, Efficient Intermodal Transportation for International Competitiveness	Robert Kleist, Vice-President, Evergreen Marine Corp.

Friday, January 10, 1986

11.0	Reports of Working Groups (Plenary Session)—Ballroom C	
	11.1 Measures of Productivity, Their Use, and Their Role in Improving Productivity	William C. Webster
	11.2 Issues in Improving Productivity	Henry Marcus
	11.3 Implications of Technological and Operational Factors for Competition and Trade	Clifford Sayre
12.0	Chairman's Summary and Closing Remarks	Clifford Sayre
	ADJOURN NATIONAL MEETING	

APPENDIX D
COMPOSITION OF WORKSHOPS

Work Group on Measures of Marine Container Terminal Productivity

William C. Webster, University of California at Berkeley, *Leader*
Edgar Ted Rust, Williams, Kubelbeck & Assoc., *Rapporteur*
Wes Allen, Georgia Ports Authority
Carmel Aquilina, Marsaxlokk Port Project, Malta
Asaf Ashar, Louisiana State University
Keith Christian, Port of Seattle
Marty Frates, IBT Local 70
Bradley Gewehr, Association of American Railroads
Roger J. Giesinger, Virginia International Terminals, Inc.
John Hachey, Port of Portland
Hugh M. Lacey, Sea-Land Service, Inc., retired
Carl Martland, Massachusetts Institute of Technology
Jeremy Mattox, Jeremy Mattox & Associates, Inc.
Eugene Pentimonti, American President Lines, Ltd.
John Pisani, Maritime Administration
Joan C. Rijsenbrij, Europe Container Terminus
Sven I. Thoolen, Matson Navigation Company
Jack Wells, Port of Los Angeles

Work Group on Issues in Improving Productivity

Henry Marcus, Massachusetts Institute of Technology, *Leader*
Gregory Doyle, Louisiana State University, *Rapporteur*
Marge Abbott, Port of Portland
Ben Andrews, S.E.A.
David Burns, Burlington Northern Railroad
Robert A. Curry, California Cartage Co., Inc.
Joel Fadem, University of California at Los Angeles
Nancy Friedman, Advanced Technology, Inc.
Michael Gaffney, Cornell University
Ronald Katims, Container Transport Technology
Jerry Lorelli, U.S. Customs Service
Brian Maher, Maher Terminals Co.
Geoffrey R. McIntyre, Department of Transportation
Robert Nolan, International Terminal Operating Co., Inc.
Brendan W. O'Malley, The Port Authority of New York/New Jersey
Ernest L. Perry, Port of Los Angeles, retired
Anthony Petrizzo, Maersk Container Service Co.
Tony E. Pittsey, Sea-Land Service, Inc.
Dan Rayacich, D. Rayacich Maritime Consultants, Inc.
Christopher Redlich, Jr., Marine Terminals Corp.
Col. Nolan Rhodes (retired), Port of Corpus Christi Authority
L. P. Robinson, American President Lines, Ltd.
J. B. Rollison, Georgia Ports Authority
Rudy Rubio, International Longshoremen's and Warehousemen's Union
Duncan Scott, Port of Long Beach
Don Sheppard, International Transportation Service
Paul Sorenson, URS Corporation
John Verheul, Port of Oakland
Thomas D. Wilcox, National Association of Stevedores

Work Group on Implications of Technological and Operational Factors for Competition and Trade

Clifford M. Sayre, E. I. du Pont de Nemours & Co., *Chairman/Leader*
Donald Walsh, International Maritime, Inc., *Rapporteur*

Charles F. Connors, Port of Long Beach
Thomas Dowd, University of Washington
Mary Dyess, National Association of Stevedores
Robert Fall, Sea-Land Service, Inc.
Kyle King, King Interests
Lee Lane, Association of American Railroads
Paul B. Mentz, Maritime Administration
Donald L. Mosman, Port of Los Angeles
Frank W. Nolan, Jr., International Terminal Operators, retired
Peter G. Sandlund, Council of European and Japanese National Shipowner's Associations
Calle Westman, Transconsultants AB
Larry Whiteneck, Moffatt & Nichol, Engineers